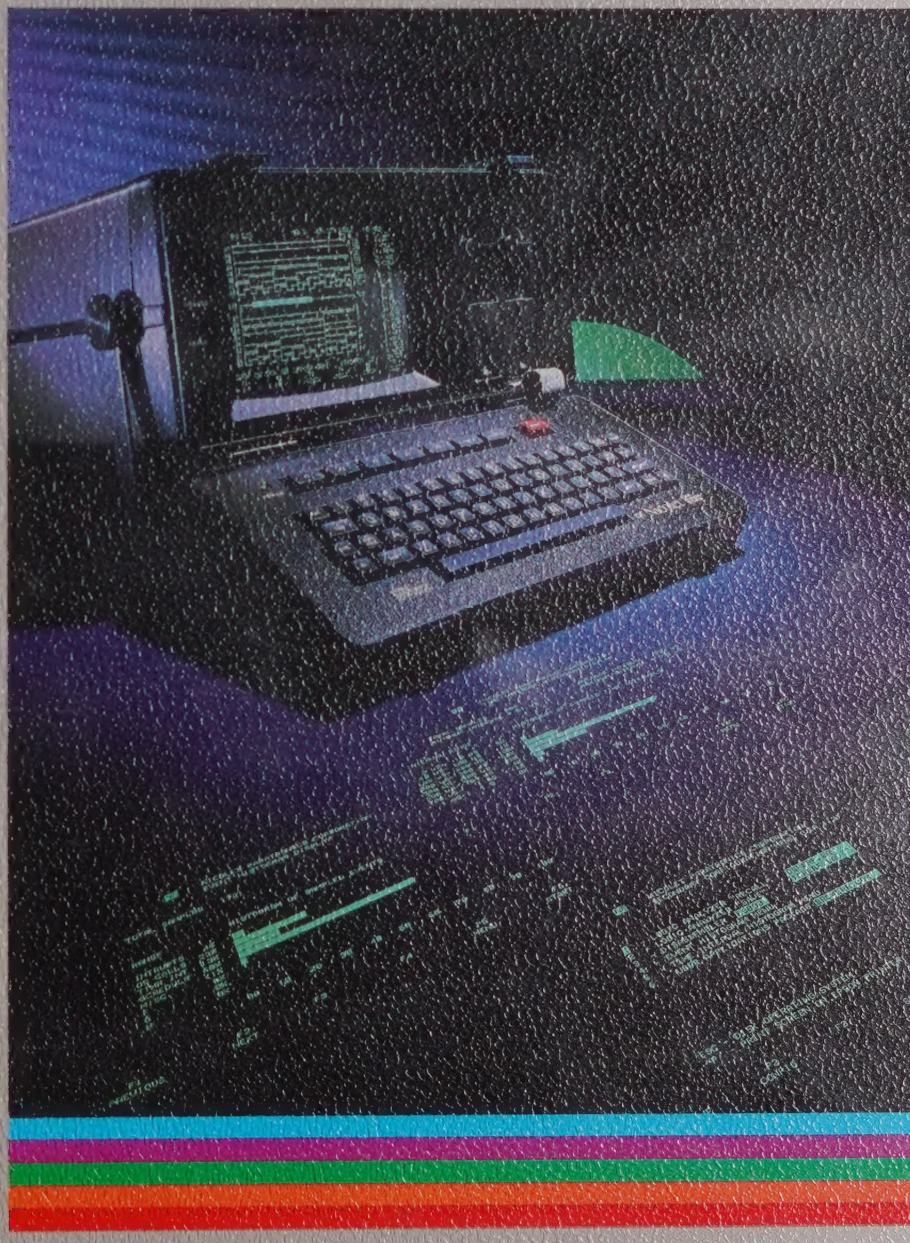
The Nicolet
800 Series
Logic Analysis Systems

Model 800D Operator's Manual



Nicolet

Model

800D

Logic Analyzer

VOLUME 1

Operator's Manual

Nicolet

Nicolet, Digital Test Division
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Fremont, California 94539 USA
415-490-8300

P/N 125-0053-0001
April, 1985
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This manual covers all NPC-800Ds beginning with serial number 1001. It may also apply to some other models and serial numbers, depending upon which options and/or updates have been installed. Refer to Section 5 for details.

CERTIFICATE OF COMPLIANCE

Nicolet, Digital Test Division certifies that this instrument complied with all published specifications at the time of shipment from the factory.

Nicolet, Digital Test Division reserves the right to enhance or modify this model with no obligation to provide these enhancements or modifications to previous buyers.

* * LIMITED WARRANTY * *

Nicolet, Digital Test Division ("NPC") guarantees your analyzer instrument against all defects in materials and workmanship for a period of one (1) year from the date of delivery to the original user. All instruments returned to NPC FREIGHT PREPAID during the one year period will be replaced or restored to proper working condition and returned to the sender without charge. We neither assume nor authorize any representative or other person to assume of us any liability in connection with the sale on any shipment of our products.

NOTE

This warranty does not apply to damage caused by shipping, negligence, accident, unauthorized repair, abuse, misuse, or modification; or to inconveniences or consequential damages occasioned by the instrument, or by breach of any expressed or implied warranty in any way whatsoever will be binding upon NPC unless executed by a duly authorized officer of the company.

This warranty gives you specific legal rights, and you may also have other rights which depend on local jurisdiction.

We reserve the right to make changes and improvements in our products without incurring any obligation to similarly alter products previously purchased.

CAUTIONS

1. BEFORE APPLYING POWER to the NPC-800D, make certain that the Programmable AC Voltage Selector Card, which plugs into the power module at the rear of the unit, is inserted in the position corresponding to the line voltage being used.

Also make certain that the PROPER FUSE IS INSTALLED. The correct fuse value for each voltage is printed on the back of the instrument, near the fuse holder.

Otherwise, serious damage to the internal switching power supply may occur.

2. DO NOT OPERATE this instrument WITH THE TOP COVER REMOVED, as cooling is reduced and may cause component failure.

3. All service other than that detailed in Section 4 should only be performed by trained maintenance personnel.

TECHNICAL ASSISTANCE

Applications and service engineers are available should you need assistance with your instrument.

In Massachusetts, Maine, Connecticut, Rhode Island, and New Hampshire call 617-664-0355.
In California call 415-490-8300.
Elsewhere in the USA call 800-NICOLET (800-642-6538).
Outside the USA, call your nearest Nicolet, Digital Test Division Sales office.

HOW TO USE THIS MANUAL

This manual has been organized to provide as much information as practical and to help you find any specific item of interest.

If this is the first time you have used a Nicolet, Digital Test Division's logic analyzer, we suggest that you at least scan Sections 1 and 2, General Information and Preparation for Use. Then proceed to Section 3 which provides step-by-step instruction for using each feature of your NPC-800D.

If you are already a user of Nicolet, Digital Test Division logic analyzers and merely need guidance in the operation of this specific model, refer to Section 3.

If you suspect that you are having equipment failure problems, Section 4 contains preliminary service and troubleshooting hints. Detailed service information is contained in the Maintenance Manual.

Section 5 provides some assistance if you have purchased an option that was not installed at the factory.

Since there is not yet a "universal definition" for many of the terms related to logic analysis, Section 6, the Glossary, was created to help reduce confusion.

Sections 7 and 8 are for safe-keeping of information related to your logic analyzer: Application Notes and User Instructions for any dedicated probes that you may purchase.

And last is an Index that should help you find the location of a specific piece of information quickly.

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Section 1
GENERAL INFORMATION

1.1 INTRODUCTION

This manual provides all the information required to understand, operate and troubleshoot the NPC-800D, one of five logic analyzers in the NPC-800 Series Logic Analysis System. These instruments have been designed to provide the digital engineer or technician with all the tools necessary to solve software or hardware problems. Each analyzer in the NPC-800 Series contains a different set of basic logic analysis capabilities and allows a number of useful options to be added to augment the basic system capabilities (see Figure 1-1).

	STATE ANALYZER	TIMING ANALYZER	SERIAL	WAVEFORM
INPUTS	NPC-800A—32 Data, 2 Clock, 6 Qual NPC-800B—48 Data, 3 Clock, 8 Qual NPC-800C—48 Data, 3 Clock, 8 Qual NPC-800D—48 Data, 3 Clock, 6 Qual NPC-800E	16 Data, Clock Qualifier	8 Data, 8 Control 8 Data, 8 Control 8 Data, 8 Control 8 Data, 8 Control	Single Channel 10μV/Division to 20V/Division
Maximum Data Rates	NPC-800A 15 MHz NPC-800B 15 MHz NPC-800C 15 MHz NPC-800D 25 MHz NPC-800E	100 MHz, 8 Channels 100 MHz, 8 Channels 200 MHz, 16 Channels 200 MHz, 16 Channels 200 MHz, 16 Channels	19.2K Baud Receive/Transmit	50 MHz 6 Bit A/D
Maximum Real-Time Memory Depth	1000 Words	2000 Words	1000 Characters	1000 Samples
Maximum Auxiliary Memory Depth	1000 Words	2000 Words	1000 Characters	1000 Samples
Trigger Levels (Steps)	NPC-800A 16 NPC-800B 16 NPC-800C 16 NPC-800D 8 NPC-800E	2 2 3 3 3	16	0%-100% Positive/Negative Slope
Delays	After N Clocks, Not on N Clocks, Before N Clocks, On N Clocks, Occurs N Times: 0≤N≤9,999			Uses Timing Analyzer Triggering/Delay Circuit
Maximum Pretrigger	999 Words	1800 Words	999 Characters	900 Samples
Display	Hex, Oct, Decimal Binary, ASCII — In Any Mix	16 Timing: Hex, Oct, Decimal, Binary, ASCII	Characters-ASCII; Control — Binary, Hex etc.	Analog Waveform (Software Smoothed or Unsmoothed
Internal Linkages	State-To-Timing Waveform	Timing-To-State, Serial, Waveform	Serial-To-Timing, Waveform	Waveform-To-Timing Serial, State

Counter/Timer	
Modes	Freq., Period, Total, Interval
Max. Input Freq.	100 MHz
Input Sources	Scope Probe (1x/10x) or State Analyzer Word Recognizers

	Signature Analyzer
Formats	STD, and Hex
Input	Scope Probe (1x/10x)
Gate	State Analyzer Word Recognizers

	I/O and Computing Facilities	
IEEE-488	Device	Controller
RS-232	Slave	Master
CP/M	T & M Processing	General Purpose Computer
Histogram Facilities	Event	Time Interval

Figure 1-1. NPC-800 Series Electronic Workbench

Detailed specifications for the NPC-800D are found in Section 1.5.

1.2 SYSTEM DESCRIPTION

The NPC-800D consists of a 48-channel state analyzer and a 16-bit channel timing analyzer. Featuring a 9-inch CRT and a standard ASCII keyboard (see Figure 1-2), it has provisions for internal and external options (see Figure 1-3). The logic analyzer operating software has 48k bytes of ROM.

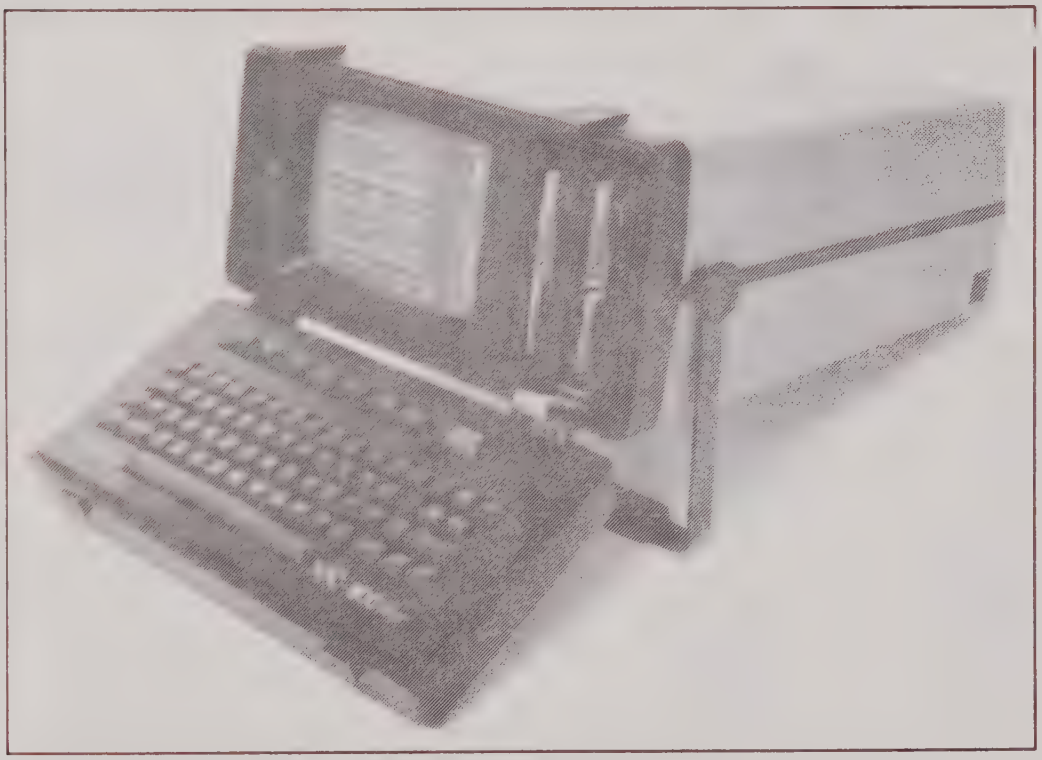

Figure 1-2. Basic NPC-800D Architecture

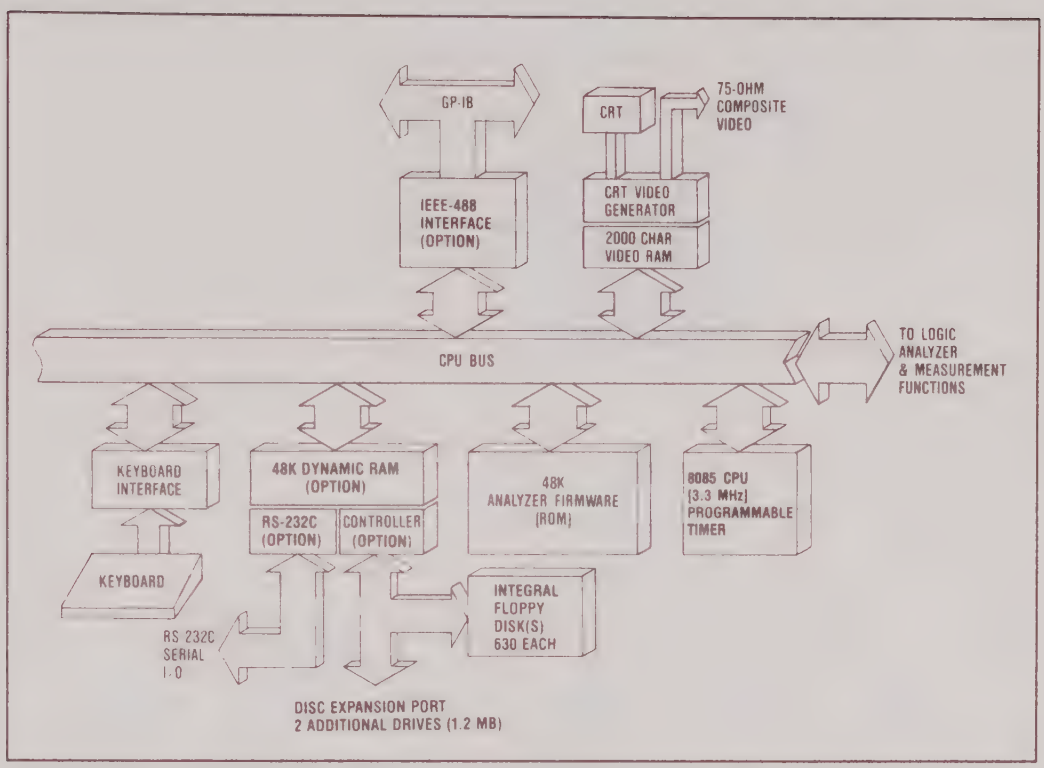

Figure 1-3. NPC-800D Architecture With All Possible Internal Options

1.2.1 Easy Operation

From start-up, all NPC-800 series instruments are easy-to- operate. Menus are organized in a natural and comfortable manner that take you quickly and simply through the desired test. Prompting messages, soft keys and labels minimize the need to refer to this manual.

Because all menus default to commonly used parameters, simple problem-solving and meaningful data collections can be performed without any special set-ups. For example, when monitoring a microprocessor operation, a single keystroke on the NPC-800 allows you to see if your ADDRESS, DATA and STATUS signals are functioning properly.

1.2.2 Rapid Set-Up

When power is applied to an NPC-800 series instrument, a Configuration List (see Figure 1-4), containing all available test and measurement modes, appears on the 9-inch, 80-character by 25-line CRT display. At the bottom of the display are labels for six software-directed (or "soft") keys that allow you to select the mode best suited to your current application. The function of each "soft" key changes each time the display changes, but the current function of each "soft" key is always shown at the bottom of the screen.

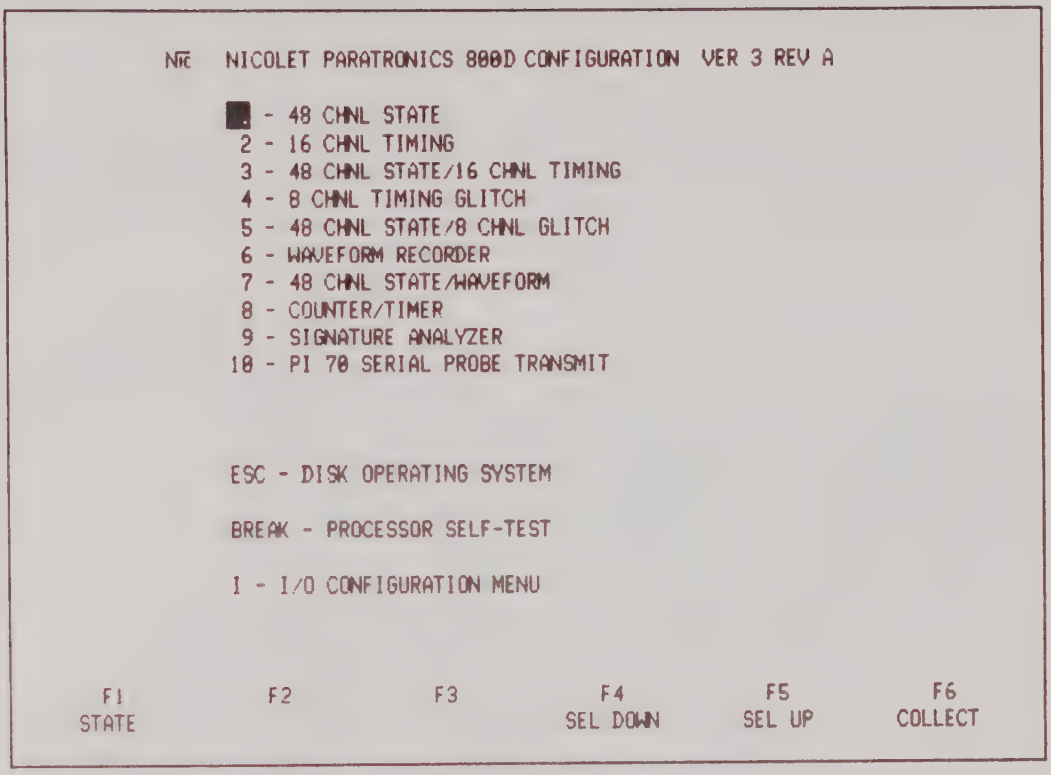
NIC NICOLET PARATRONICS 800D CONFIGURATION VER 3 REV A
1 - 48 CHNL STATE
2 - 16 CHNL TIMING
3 - 48 CHNL STATE/16 CHNL TIMING
4 - 8 CHNL TIMING GLITCH
5 - 48 CHNL STATE/8 CHNL GLITCH
6 - WAVEFORM RECORDER
7 - 48 CHNL STATE/WAVEFORM
8 - COUNTER/TIMER
9 - SIGNATURE ANALYZER
10 - PI 70 SERIAL PROBE TRANSMIT
ESC - DISK OPERATING SYSTEM
BREAK - PROCESSOR SELF-TEST
I - I/O CONFIGURATION MENU
F1 STATE
F2
F3
F4 SEL DOWN
F5 SEL UP
F6 COLLECT

Figure 1-4. Configuration Menu

Once the desired mode is selected, the corresponding menu is displayed with its own set of soft-key labels. The soft keys allow you to access the menu fields so you can "enter in" test parameters from the ASCII keyboard. If an entry error occurs, a message appears on the CRT telling you which keys are valid for the current menu operation.

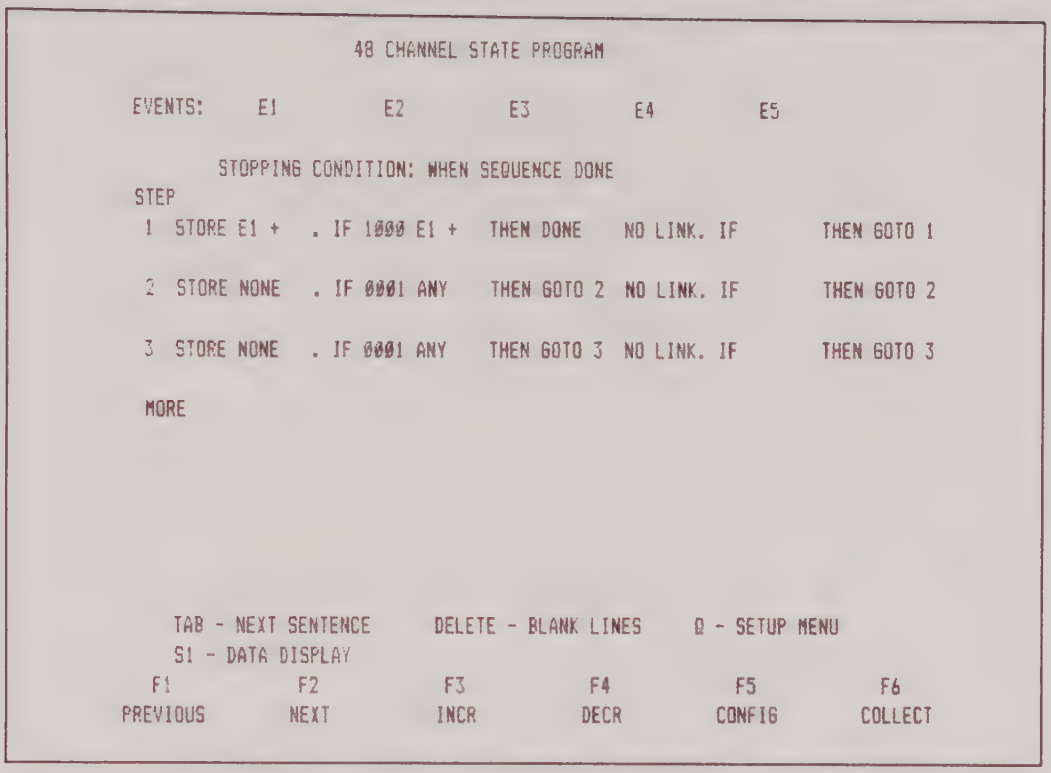
48 CHANNEL STATE PROGRAM
EVENTS: E1 E2 E3 E4 E5
STOPPING CONDITION: WHEN SEQUENCE DONE
STEP
1 STORE E1 + . IF 1000 E1 + THEN DONE NO LINK. IF THEN GOTO 1
2 STORE NONE . IF 0001 ANY THEN GOTO 2 NO LINK. IF THEN GOTO 2
3 STORE NONE . IF 0001 ANY THEN GOTO 3 NO LINK. IF THEN GOTO 3
MORE
TAB - NEXT SENTENCE DELETE - BLANK LINES 0 - SETUP MENU
S1 - DATA DISPLAY
F1 F2 F3 F4 F5 F6
PREVIOUS NEXT INCR DECR CONFIG COLLECT

Figure 1-5. State Menu (Three of Eight Steps of Triggering are Shown)

Menu fields controlling advanced triggering modes can be turned off at any time, reducing your triggering set-up to a simpler form. In this manner, you can check that basic triggering conditions can be satisfied before activating the advanced set-up. This illustrates the time-saving, "start simple and build" philosophy behind the NPC-800 series. Advanced features do not obstruct simple problem-solving. They are available and readily accessible when you need them.

1.2.3 Logic State Analyzer

Readily accessed through the ASCII keyboard, each NPC-800 series analyzer incorporates a logic state section featuring some of the most powerful software debugging features available in the industry. Upon initial selection, the state menu defaults to commonly-used parameters so you can collect meaningful data immediately.

When more debugging power is needed, you can "build" on the basic state menu by calling up additional triggering levels, qualifiers, and other features. Operator prompts minimize your set-up time. A typical NPC-800D state clock and qualifier setup menu is shown in Figure 1-6.

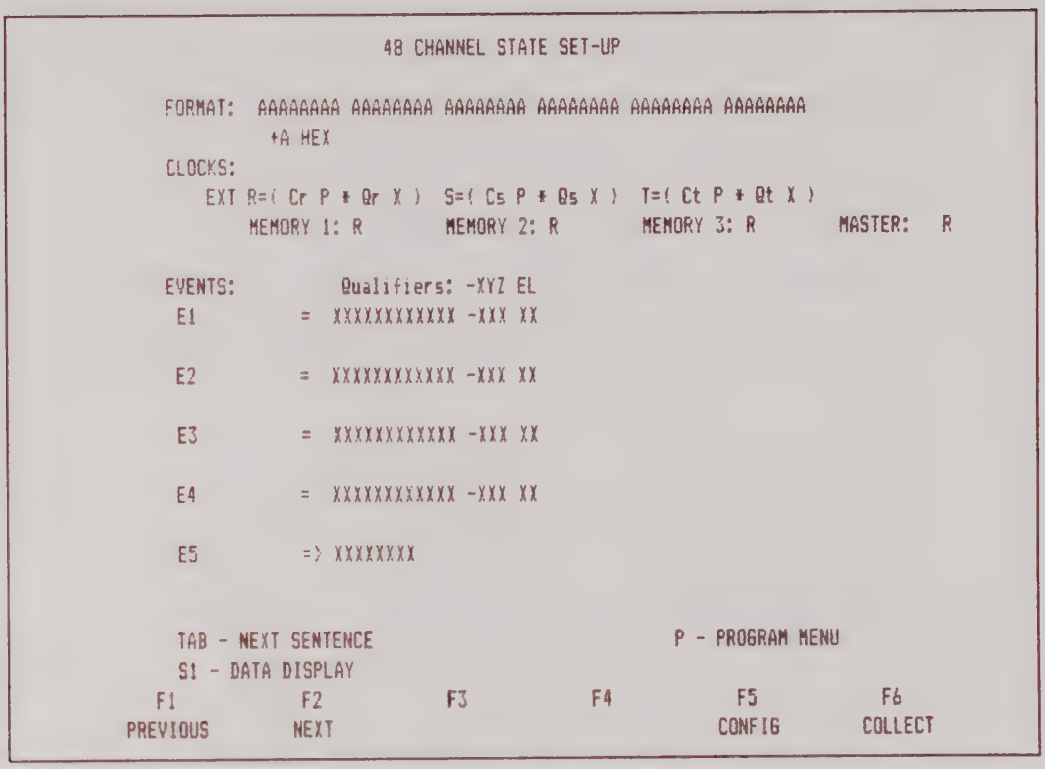
48 CHANNEL STATE SET-UP
FORMAT: AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA
+A HEX
CLOCKS:
EXT R=(Cr P * Qr X) S=(Cs P * Qs X) T=(Ct P * Qt X)
MEMORY 1: R MEMORY 2: R MEMORY 3: R MASTER: R
EVENTS: Qualifiers: -XYZ EL
E1 = XXXXXXXXXXXX -XXX XX
E2 = XXXXXXXXXXXX -XXX XX
E3 = XXXXXXXXXXXX -XXX XX
E4 = XXXXXXXXXXXX -XXX XX
E5 => XXXXXXXX
TAB - NEXT SENTENCE
P - PROGRAM MENU
S1 - DATA DISPLAY
F1 PREVIOUS
F2 NEXT
F3
F4
F5 CONFIG
F6 COLLECT

Figure 1-6A. NPC-800D State Setup Menu

1.2.3.1 Software Analysis

The state analyzer section for the NPC-800D is summarized below:

State Channels	Clock Qualifiers	Number of Clock Inputs	Main Memory Depth	Auxiliary Memory Depth	Trigger Levels	Pretrig-gering
48	3 Bits and Five, 53-Bit Words	3	1000 Words	1000 Words	8 Complex Statements	0-999 Words

The state analyzer allows you to collect ADDRESS, DATA, STATUS, or other synchronous occurrences from the digital portion of your system, at real-time rates up to 25 million events per second. And each instrument features menu-controlled linkage to internal or external test and measurement functions.

1.2.3.2 Collecting Qualified Data

NPC-800's Qualification mode extends trace capabilities of each state analyzer's 1000-word memory by restricting the data collection to specific events of interest. The clock qualification fields in the state setup menu are individual input signals that are logically ANDed with the clock signals prior to acceptance of the clock. Any event specified in the setup menu can be used in the state program menu to select specific words to be stored (see Figure 1-6).

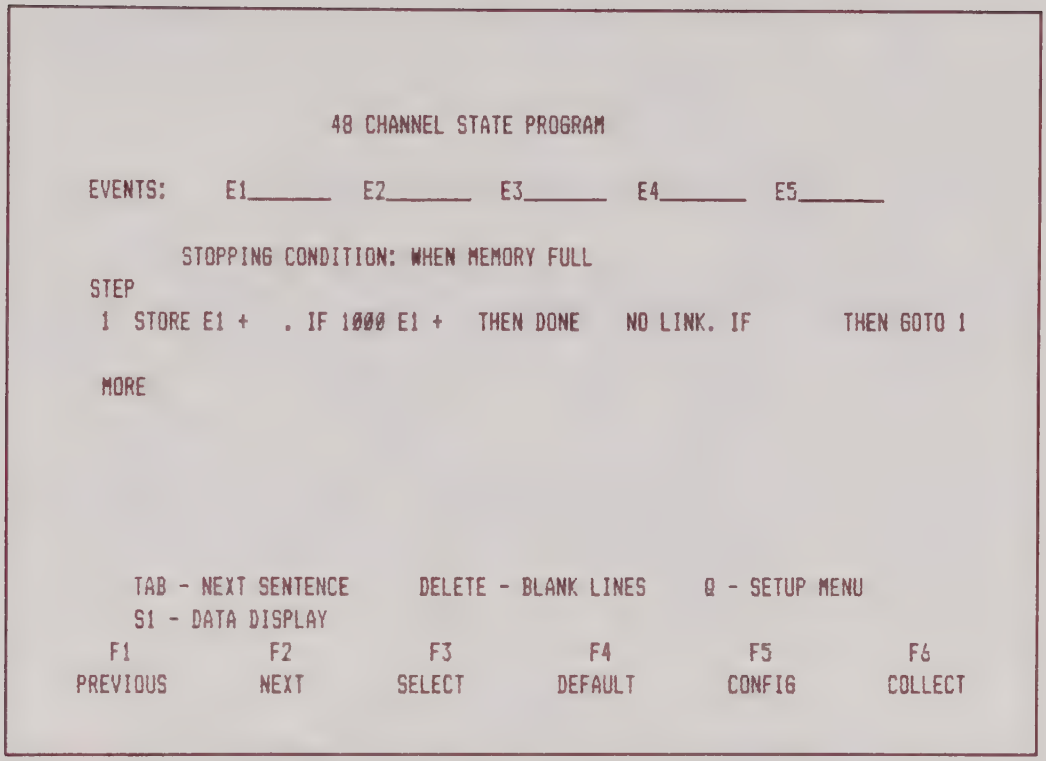

Figure 1-6B. NPC-800D State Program Menu

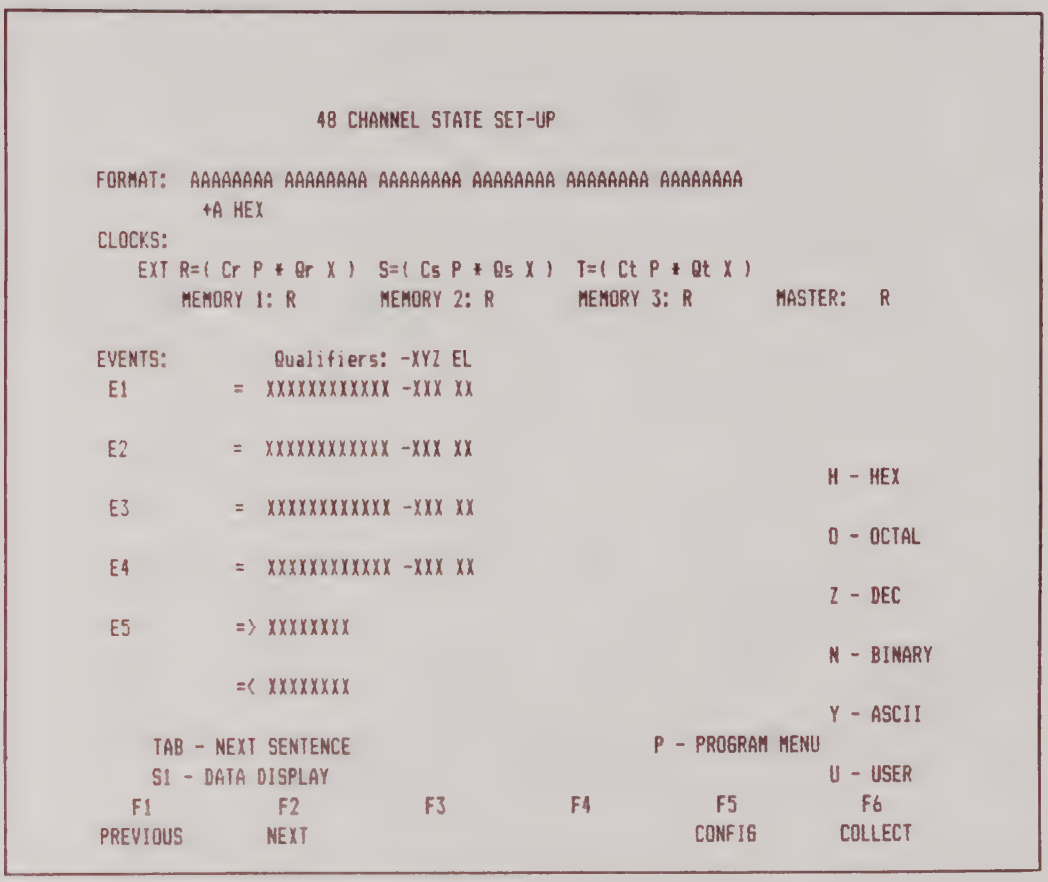
48 CHANNEL STATE SET-UP
FORMAT: AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA
+A HEX
CLOCKS:
EXT R=(Cr P + Qr X) S=(Cs P + Qs X) T=(Ct P + Qt X)
MEMORY 1: R MEMORY 2: R MEMORY 3: R MASTER: R
EVENTS: Qualifiers: -XYZ EL
E1 = XXXXXXXXXXXX -XXX XX
E2 = XXXXXXXXXXXX -XXX XX
E3 = XXXXXXXXXXXX -XXX XX
E4 = XXXXXXXXXXXX -XXX XX
E5 => XXXXXXXX
=< XXXXXXXX
H - HEX
O - OCTAL
Z - DEC
N - BINARY
Y - ASCII
U - USER
TAB - NEXT SENTENCE
S1 - DATA DISPLAY
P - PROGRAM MENU
F1 PREVIOUS
F2 NEXT
F3
F4
F5 CONFIG
F6 COLLECT

Figure 1-7. Clock Qualifier Field

The events specified in the STORE field are used to "self-qualify" the data coming into the analyzer from the probes. If a match occurs between the pattern set into the STORE field and an incoming data word, then that data word is clocked into the memory. Since the data qualifier field can be as wide as the maximum number of channels of the state analyzer, one application of this function is to collect data over a certain range of addresses or data words. This is accomplished by specifying, in the EVENTS field, only the significant address or data bits, or by using the range definition field.

To control the data collection, the external clock qualifier fields use separate lines (one per 16-channel state probe plus two BNC inputs at the rear of the analyzer). To clock data into the memory, if one or more of the bits in the external field are set, the signals on the corresponding probe qualifier lines must match. A typical application is to use microprocessor control signals to restrict the data collection to memory, I/O or other particular operations of interest.

Data qualifier fields for each NPC-800D state analyzer are partitioned as follows:

Internal Field	External Field		Total State Clock Qualifier Field
Data Probe Inputs	Data Probe Qualifiers	EXT BNC Connectors	
48	3	2	53

1.2.3.3 Multiphase Clocking

Multiphase clocking allows data from the 16-channel state probes to be strobed into the analyzer at different times but displayed as if all incoming data were present simultaneously. For example, to simplify program tracing, an ADDRESS/DATA bus can be demultiplexed so that address and corresponding data words are displayed side-by-side.

1.2.3.4 Complex Multistep Triggering

For branch and subroutine analysis, all NPC-800D state analyzers offer multistep triggering with auto or manual restart capabilities. Using the state program menu, you can build up to 8 steps of programmed triggering to trace deeply-nested sections of your code (see Figure 1-8).

```
                    48 CHANNEL STATE PROGRAM

EVENTS:     E1          E2          E3          E4          E5

        STOPPING CONDITION: WHEN MEMORY FULL
STEP
 1  STORE E1 +   . IF 1000 E1 +   THEN DONE    NO LINK. IF        THEN GOTO 1

 2  STORE NONE   . IF 0001 ANY    THEN GOTO 2  NO LINK. IF        THEN GOTO 2

 3  STORE NONE   . IF 0001 ANY    THEN GOTO 3  NO LINK. IF        THEN GOTO 3

 4  STORE NONE   . IF 0001 ANY    THEN GOTO 4  NO LINK. IF        THEN GOTO 4

 5  STORE NONE   . IF 0001 ANY    THEN GOTO 5  NO LINK. IF        THEN GOTO 5

 6  STORE NONE   . IF 0001 ANY    THEN GOTO 6  NO LINK. IF        THEN GOTO 6

 7  STORE NONE   . IF 0001 ANY    THEN GOTO 7  NO LINK. IF        THEN GOTO 7

 8  STORE NONE   . IF 0001 ANY    THEN GOTO 8  NO LINK. IF        THEN GOTO 8
    TAB - NEXT SENTENCE      DELETE - BLANK LINES     0 - SETUP MENU
    S1 - DATA DISPLAY
  F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT        INCR        DECR        CONFIG      COLLECT
```

Figure 1-8. Default 48-Channel State Program Menu With All Available Steps

For a data collection to occur, the incoming data from the probes, at each trigger level, must match the patterns specified in the STORE field.

Furthermore, at each trigger step, users can specify a combination of events to be recognized, then either stop the collection or go to another step in the trigger program sequence. Users can also specify that the current trigger word occur "n" times, or wait for "n" master clocks before the state analyzer advances to the next step in the sequence.

In all, each NPC-800D state analyzer offers state triggering and qualification combinations which can handle virtually any debugging requirement.

For additional time-savings, all NPC-800D state analyzers display test codes that provide a quick, shorthand method of uniquely identifying your data collection. For each block of collected data, 16 bits wide by 1000 words deep, a 4-digit hexadecimal test code is computed by the analyzer using a data compression algorithm. Thus, two data collections can be quickly compared by simply comparing the "test code".

To further save time, you can put your NPC-800 to work overnight to detect and isolate hard-to-find, intermittent failures. Using the state auxiliary memory and a special triggering mode called HOLD IF EQUAL (or HOLD IF NOT EQUAL), you can compare a known reference collection to unknown incoming data. If the two collections match (or differ), the test is automatically repeated. If an equal or difference is detected, the NPC-800 displays the collection with all differences highlighted, ready for inspection when you arrive at work the next morning.

1.2.3.5 State Analysis—Only One Part Of The Electronic Workbench

The state analyzer's debugging power is further enhanced when used with other test and measurement functions. For example, the state analyzer can be linked to the timing analyzer and analog waveform recorder for cross-domain analysis; with the counter-timer/signature analyzer for system performance measurements; with the serial analyzer for debugging RS-232 interfaces; and with other external instruments as part of a completely automatic test system.

1.2.3.6 Additional Time-Saving Features

To further save analysis time, data can be specified in the state menu for display in any combination of hexadecimal, octal, decimal, binary, or ASCII characters. Displayed information can be grouped into as many as six different fields, with each field one or more bits wide. You can also blank one or more bits anywhere in the data field. Using optional disassembly software, microprocessor ADDRESS, DATA, and STATUS words are disassembled into an easy-to-read, mnemonic format.

1.2.4 Independent Timing Analyzer

For hardware debugging, each NPC-800D analyzer incorporates an independent timing analyzer with advanced triggering, data collection, and display capabilities. Like the state analyzer section, these capabilities, when initially selected, default to the most commonly used parameters so you can collect meaningful data with a minimum of keystrokes. For more in-depth hardware analysis, simple ASCII keyboard commands, which are coupled with operator prompts, reduce the time needed in setting up complex tests. A typical NPC-800D timing menu is shown in Figure 1-9.

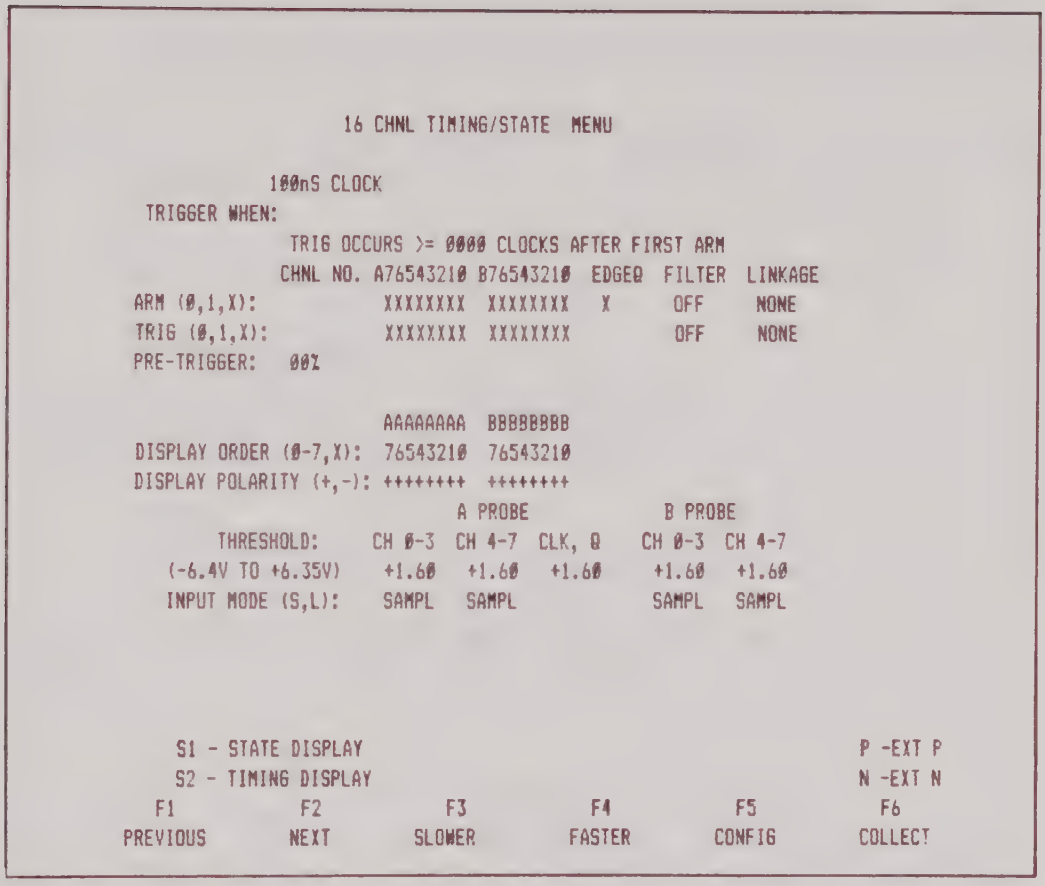
16 CHNL TIMING/STATE MENU
100nS CLOCK
TRIGGER WHEN:
TRIG OCCURS >= 0000 CLOCKS AFTER FIRST ARM
CHNL NO. A76543210 B76543210 EDGE0 FILTER LINKAGE
ARM (0,1,X): XXXXXXXX XXXXXXXX X OFF NONE
TRIG (0,1,X): XXXXXXXX XXXXXXXX OFF NONE
PRE-TRIGGER: 00%
AAAAAAAA BBBBBBBB
DISPLAY ORDER (0-7,X): 76543210 76543210
DISPLAY POLARITY (+,-): ++++++++ ++++++++
A PROBE B PROBE
THRESHOLD: CH 0-3 CH 4-7 CLK, 0 CH 0-3 CH 4-7
(-6.4V TO +6.35V) +1.60 +1.60 +1.60 +1.60 +1.60
INPUT MODE (S,L): SAMPL SAMPL SAMPL SAMPL
S1 - STATE DISPLAY
S2 - TIMING DISPLAY
P -EXT P
N -EXT N
F1 PREVIOUS
F2 NEXT
F3 SLOWER
F4 FASTER
F5 CONFIG
F6 COLLECT

Figure 1-9. NPC-800D Timing Menu

1.2.4.1 Powerful Hardware Analysis

The timing analyzer section for the NPC-800D is summarized below.

Timing Channels	Max Sampling Rate	Main Memory Depth	Auxiliary Memory Depth	Glitch Capture	External Clock Input	External Clock Qualifier
16	16 ch; @ 200 MHZ	16 ch; @ 1000 words	16 ch; @ 1000 words	YES	1 DC to 75 MHz	1

Like the state section, the NPC-800's timing analyzer can be linked to other internal or external test and measurement functions to closely couple the analysis of state, timing and analog events.

1.2.4.2 Advanced Triggering

The optimum number of triggering levels for a timing analyzer is two because only one level makes relatively routine timing measurements difficult. More than two levels implies branch and subroutine tracing applications which are best performed by the state analyzer.

For this reason, NPC-800's timing analyzer includes two levels of word recognition: ARM and TRIG. A significant advantage is that the analyzer **trigger events are processed at up to 200 MHz, 16-channels wide**.

When you use both trigger levels, three conditions must be satisfied before the timing analyzer will display collected data:

1. the ARM event must occur,

2. the specified delay between ARM and TRIG must be satisfied, and

3. the TRIG event must occur.

Because of the large number of interactive signals in today's digital systems, it is necessary for a timing analyzer to provide the user flexibility in specifying the time relationship between the ARM and TRIG events. The NPC-800's timing analyzer accomplishes this through the following powerful delay modes:

- TRIG occurs GREATER THAN nnnn clocks AFTER FIRST ARM
- TRIG occurs AFTER nnnn ARMS

In the above modes, GREATER THAN can be changed to LESS THAN or ON; AFTER can be changed to BEFORE; FIRST can be LAST; $\overline{\text{ARM}}$ can be substituted for ARM; and $\overline{\text{TRIG}}$ for TRIG. The bar symbol over the ARM and TRIG words identifies the nonoccurrence triggering mode.

Thus, for example, if an expected TRIG event was not occurring exactly nnnn clocks after the ARM event had ended, you would simply use the following triggering mode to see what was really happening:

$\overline{\text{TRIG}}$ occurs ON nnnn clocks AFTER LAST ARM

In all, there are approximately 150 timing triggering combinations which can satisfy virtually any hardware debugging requirement.

If your problem is broader in nature, involving hardware-software or even digital-analog interactions, you can readily link the triggering of the timing analyzer to various combinations of state, waveform, or other, external measurement resources. For example, by linking the timing and state sections, you can observe and measure the performance of both the hardware interrupts and the associated software routines.

1.2.4.3 Complex Timing Measurements Made Easy

Because timing information is generally more difficult to analyze than state or analog information, a good timing analyzer should have extensive, yet easy-to-use, display manipulation capabilities. The display facilities of the NPC-800's timing analyzer have evolved through four generations of analysis instruments and provide one of the most useable presentations of timing information on the market.

For instance, when timing information is displayed, a moveable, inverse video graticule gives you an overview of the position and amount of data being displayed relative to the entire contents of the timing memory (see Figure 1-10).

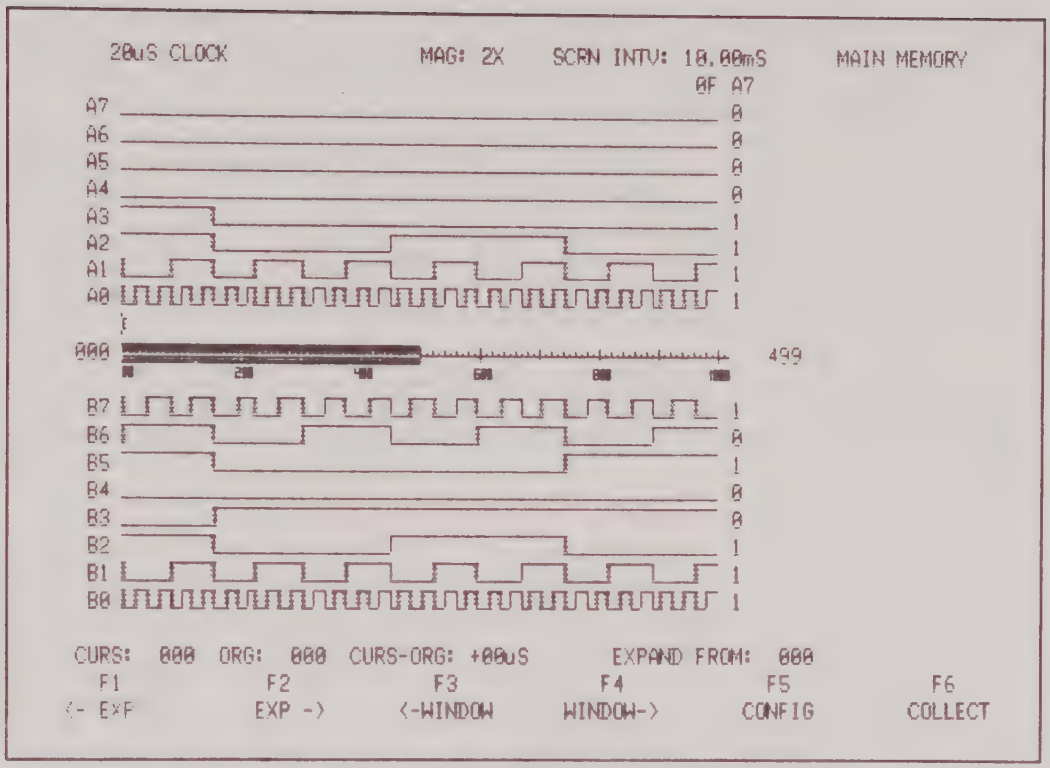

Figure 1-10. Typical NPC-800 Timing Display at 20X Magnification

Furthermore, all important timing parameters—sample rate, magnification factor (up to X20), screen interval, and cursor locations and origin—are all shown with displayed data so you don't have to go back to the parameters in the menu to make sense of your timing measurements.

To make the display more meaningful, you can name each channel with the 8-character label of your choice.

If you need to rearrange the display order and polarity you don't have to adjust the probes; simply make the necessary changes in the timing menu. Probe input comparator thresholds are also ASCII-keyboard selectable. A single keystroke gives you a state-equivalent display that can then be formatted in hexadecimal, octal, binary, decimal or ASCII.

1.2.4.4 Comparison Testing

Like the state analyzer, the timing section has a separate, matching, auxiliary memory for comparing current data collection with a known good reference. A CORRELATION function is used that tells you (mathematically on a channel-by-channel basis) how closely main and auxiliary data collections match.

For example, if pulses are intermittently missing in a hardware sequencer, data in the main and auxiliary memories differ. Thus, the correlation factor for that particular channel will be low. A single keystroke selects a main/auxiliary memory comparison mode to automatically highlight those missing pulses.

If you'd like to have a permanent record of this and any other tests, and the associated menu, simply save them on the optional diskette.

1.2.4.5 High Speed Collecting

For high-speed work, you can select the 200 MHz internal clock speed. The NPC-800D actually processes the ARM and TRIG events at up to 200 MHz. Thus, you can trigger and collect 1000 samples at five nanosecond intervals, increasing the probability of capturing and viewing those high-speed problems.

1.2.4.6 Timing Memory Reconfiguration

Another mode, the 8-CHANNEL GLITCH, partitions 16-channel timing memory into an 8-channel glitch memory and a corresponding 8-channel data memory. This mode is used to display glitches as they occur in relationship to actual data, superimposing the glitch data onto the timing data.

1.2.4.7 Keyboard

One of the most time-saving features of the NPC-800D is its standard ASCII keyboard (see Figure 1-11). This keyboard allows the operator to send data to the computer and to make data entries or menu changes in the logic analyzer and other analysis sections of the instrument. Most keys are the same as they are on an ordinary terminal or typewriter; that is, they type the same alphanumeric characters. This familiar arrangement permits faster programming and menu set-ups without learning dedicated keys.

For their mutual protection during transport, the keyboard assembly folds up conveniently over the CRT and optional disk drives.

Figure 1-11. Detachable, Folding Keyboard

When you turn on the NPC-800D, allow 30 seconds for the CRT to warm up. The NPC-800D is in the Analyzer mode upon power up. The initial display is a list of analysis functions. To use the keyboard for computer operations, escape Analyzer mode by pressing ESC key. Then load a CP/M diskette as described in paragraph 3.18. After the CP/M version number appears, you should then see a line and a blinking reverse video block cursor in the upper left-hand corner (the home position) of the screen.

The cursor identifies where the next character can be written. The screen contains 2000 normal character positions or 25 lines of 80 characters each. Only one character can occupy a character position at any given time and will remain there until it is erased or replaced. Upon pressing ESC key, the processor clears the screen by placing spaces in all character positions.

The keyboard consists of single-pole/single-throw switches in a matrix which are scanned by keyboard-encoding hardware located in the keyboard. The hardware is periodically polled by the software.

1.2.4.8 Alphabetic Keys

The keyboard incorporates the standard 26 letters of the alphabet (in lower-case or upper-case as determined by the SHIFT key). Use the CAPS LOCK key to obtain upper-case letters only.

1.2.4.9 Nonalphabetic Keys

Nonalphabetic keys are those with double markings. These include the numbers 0 through 9, punctuation marks, and special characters. The lower marking is generated when the SHIFT key is released, while the upper marking is generated with the SHIFT key down. The CAPS LOCK key will not shift these keys.

1.2.4.10 Nondisplayable Keys

In addition to the standard typewriter keys, the following eleven function keys are included in the keyboard:

RETURN — Moves cursor to first character position. If cursor is already at first character position, it remains there. RETURN is also called "carriage return" (CR). An automatic line feed is included in the RETURN function.

LINE FEED — Moves cursor down one line. If cursor is at bottom line, a LINE FEED causes it to remain there, but all data on screen moves up one line. The top line is lost as it is scrolled up and off screen.

SPACE BAR — Causes cursor to move one character position to the right. If you depress SPACE BAR when cursor is at right end of a line, cursor remains there since neither a carriage return nor a line feed is generated.

BACK SPACE — Moves cursor one space to left. If cursor is at start (left end) of a line, it will not move when BACK SPACE key is depressed.

DELETE — Causes last character entered to be cancelled and erased in the input buffer.

TAB — Moves cursor to next tab stop (eight character spaces) to the right. Using columns numbered from 1 through 80, tab stops are fixed at 9, 17, 25, 33, 41, 49, 57, 65, and 73. If cursor is at a character position 73 through 79, it only moves one character position to the right each time the TAB key is depressed. If cursor is at character position 80, it will not move.

ESC (Escape) — In a general sense, causes software to enter and exit special modes. Normally this key is only useful when the computer option is installed.

REPEAT — When this key is held down, with another key, it repeats the function of the other key as long as both keys are held down. The repeat rate is approximately five-characters per second.

BREAK — This key is generally used to tell a computer that you wish to interrupt program execution. With the Configuration List displayed, break key initiates PROCESSOR SELF-TEST.

S1, S2 — These two keys are special keys that function according to prompts in the logic analyzer menus.

CTRL — To send control codes to the processor, hold down this key while one of the other keys is depressed.

1.2.4.11 Special Keys (F1-F6, LABELS, RESET)

F1-F6 — There are six software-directed ("soft") keys below the CRT that are automatically labeled on the screen by software.

LABELS — Depressing the LABELS key causes a prompting message to appear on right-hand side of CRT. Prompting message is dependent on analysis mode. It lists keys that can be selected to alter menus, change display formats, and save or recall data.

RESET — The red RESET key returns the NPC-800D to an initial power-on condition: processor RAM is cleared and the CONFIGURATION LIST appears on the CRT. A beep indicates completion of RESET. All analyzer setups are restored to their default state.

To avoid causing an accidental RESET, this key must be held down for approximately two seconds.

NOTE

RESET erases all menu parameters and any memory data.

1.3 ACCESSORIES SUPPLIED

1.3.1 General Purpose Probes

To simplify interconnections, each NPC-800D is supplied with a complete set of probes and terminators. Three probe types are available: the Model 51A, the Model 81A and the Model 87. Each Model 51A accommodates 16 state channels, two qualifiers and an external clock. Each Model 81A probe accommodates 8 timing channels, 1 qualifier and a clock. The Model 87, which is actually a set of 5 dual-channel probes, is offered as an alternative to the Model 81A. Whereas the Model 81A is perfectly suitable for monitoring signals that are physically in the same general area of your system, the Model 87 is ideal for the analysis of large systems where monitoring points can be as far as eight feet apart (see Figures 1-12 and 1-13).

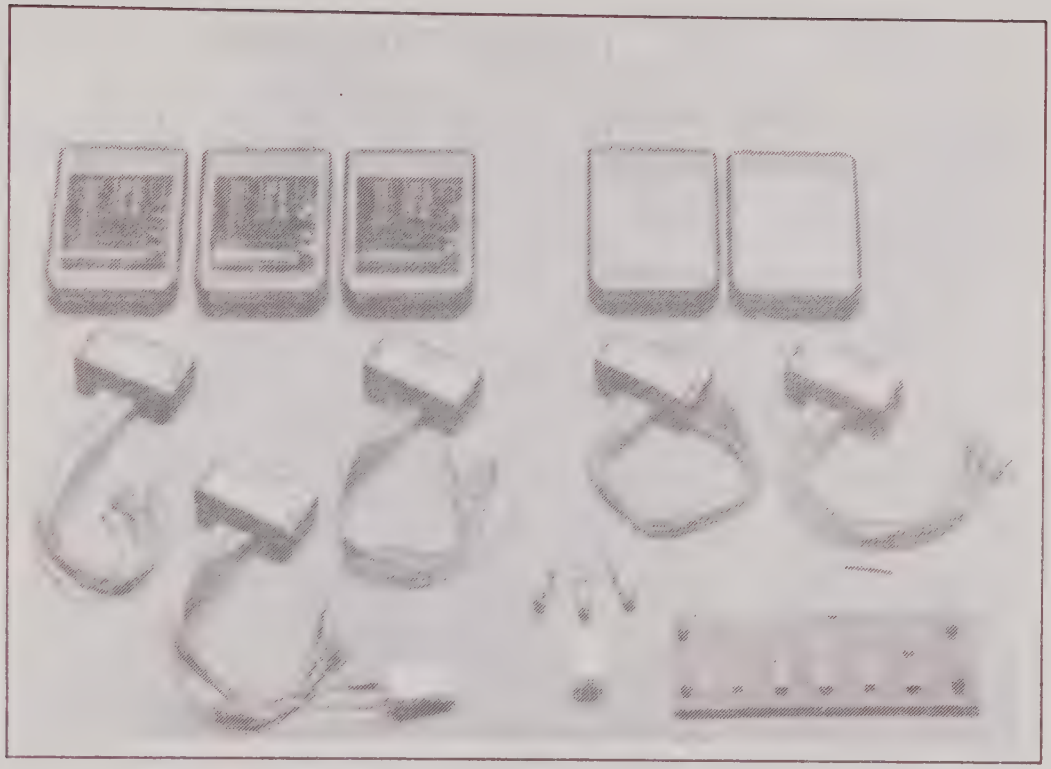

Figure 1-12. Standard Probes and Accessories

Figure 1-13. Optional Model 87 Probe Set (Replaces Model 81)

When optional test and measurement functions are installed, such as waveform or counter timer/signature analyzers, a Model 90 X1/X10 probe is provided.

For all probes, compatible terminators are included. These are color-coded and labeled for easy identification. State and timing probe terminators interface with IC clips, wire-wrap pins, and spring-loaded miniature grabbers.

1.3.2 Basic Equipment

The following items form the basis of **every** shipment:

1. NPC-800D Logic Analysis System

2. Probes

   Each state and timing analyzer has the following probes as standard:

   - **State Analyzer:** Three Model 51A state probes (16-channel variable threshold).

   - **Timing Analyzer:** Two Model 81A timing/state probes (8-channel variable threshold timing).

3. Probe Terminators

   For connection to the system-under-test. The following probe terminators are standard:

   - **Model 52-1:** One provided with each Model 51A probe.

   - **Model 82-1:** One provided with each Model 81A probe.

   - **Model 83-1:** One provided with each Model 81A probe.

   NOTE

   A package of 30 "grabbers" is included with the terminators.

4. Miscellaneous Items

   - Accessory case
   - Three-wire line cord
   - Logic analyzer test card
   - Operator's manual

1.4 OPTIONS DESCRIPTIONS

1.4.1 Nonvolatile Memory

To further reduce test time, one or two integral 5½-inch floppy disk drives can be installed in the NPC-800D. Simple commands allow you to store menu set-ups and test results. Later, these tests can be recalled and executed. A blank diskette can accommodate approximately fifty individual tests.

Figure 1-14. NPC-800D With Disk Drives Installed

1.4.2 Diskette

The NPC-800D uses a 5¼-inch, double-sided, double-density flexible disk drive. When buying additional diskettes, specify certified double-density, two-sided operation diskettes. Nicolet Paratronics' P/N 112-0503-0002 is Dysan's model 204-2D, PN802067 soft-sector, double-sided, double-density, 96/100 tracks or an equivalent.

Each of the two integral floppy disk drives use a 5¼-inch, double-sided, double-density, soft-sectored, 96 TPI diskettes, with 660k bytes of formatted capacity. There is a connector at the rear of the NPC-800D which, using an external, dual-drive expansion chassis, allows you to expand the disk memory system.

1.4.3 Waveform Analyzer

Though there are many digital systems, you still have to find problems caused by analog signals. That's why NPC offers a plug-in, waveform analyzer option for the NPC-800 series.

The waveform analyzer plug-in, which provides cost-effective, high-speed, analog waveform recording, can be used to uncover problems resulting from analog and digital interactions in your system. Using a 6-bit, a/d converter, analog signals are sampled at rates to 50 MHz, providing an effective 3 dB bandwidth of 10 MHz.

Each time a data collection is initiated, 1000 samples are stored. Displayed sample points are software-smoothed for readability.

1.4.4 Powerful Analog Analysis

The waveform analyzer section is summarized below:

No. Of Analog Channels	Max Sampling Rate	Main* Memory Depth	Auxiliary* Memory Depth	External Clock Input	Input Voltage Range	Pre-Trigger Data
1	50 MHz	1000 Samples	1000 Samples	1	5mV/DIV to 200 V/DIV	0-999 Samples

*The waveform analyzer uses the timing analyzer's main and auxiliary memories.

Like the state and timing analyzer sections, the waveform analyzer can be linked to other internal or external test and measurement functions.

1.4.5 Scope-Type Menu

Because it incorporates familiar, scope-like parameters, the waveform menu is easy to use. To record a waveform, select PROBE TYPE, (X1/X10), INPUT COUPLING, ATTENUATOR, DC OFFSET, TRIGGER LEVEL, and TRIGGER SLOPE. Next, select the Free Run or Single Shot mode and choose an appropriate sample rate, up to 50 MHz (see Figure 1-15).

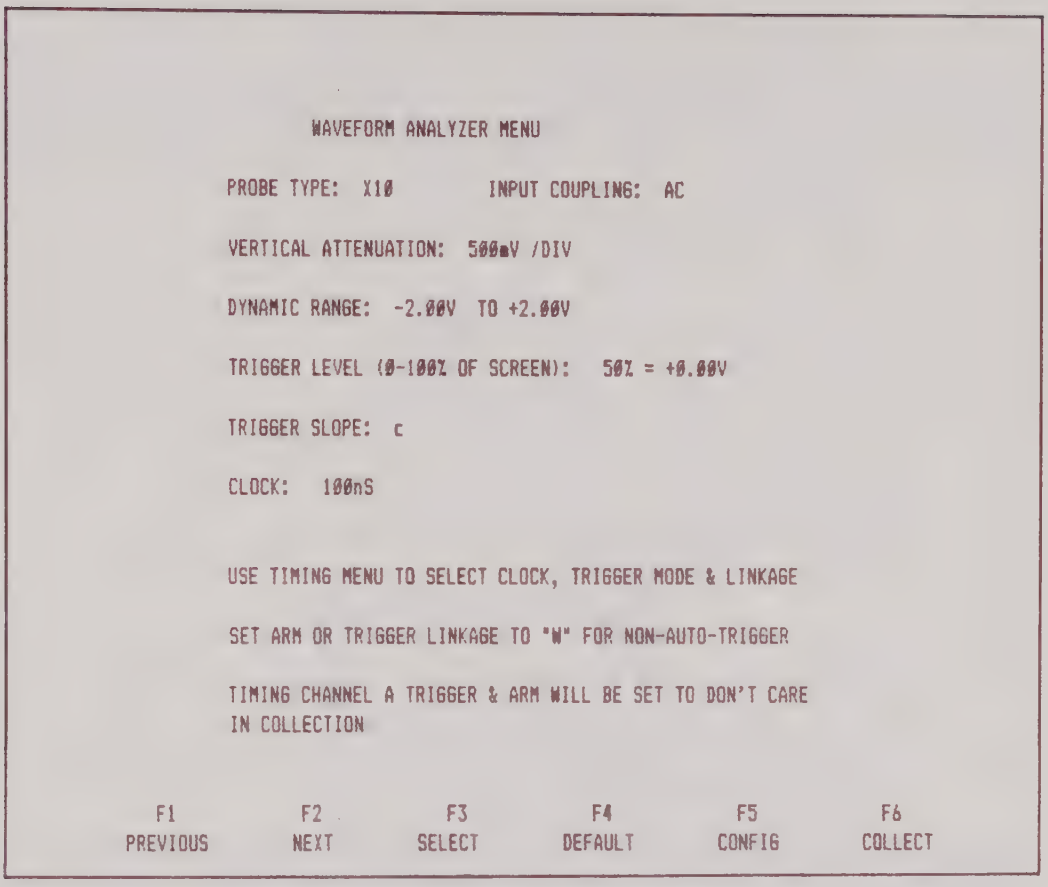
WAVEFORM ANALYZER MENU
PROBE TYPE: X1Ø
INPUT COUPLING: AC
VERTICAL ATTENUATION: 5ØØmV /DIV
DYNAMIC RANGE: -2.ØØV TO +2.ØØV
TRIGGER LEVEL (Ø-1ØØ% OF SCREEN): 5Ø% = +Ø.ØØV
TRIGGER SLOPE: C
CLOCK: 1ØØnS
USE TIMING MENU TO SELECT CLOCK, TRIGGER MODE & LINKAGE
SET ARM OR TRIGGER LINKAGE TO "W" FOR NON-AUTO-TRIGGER
TIMING CHANNEL A TRIGGER & ARM WILL BE SET TO DON'T CARE IN COLLECTION
F1 PREVIOUS
F2 NEXT
F3 SELECT
F4 DEFAULT
F5 CONFIG
F6 COLLECT

Figure 1-15. Typical NPC-800D Waveform Menu

When an incoming analog signal meets the threshold and slope requirements that you have set into the menu, the waveform analyzer triggers and collects 1000 samples. These samples are stored in the timing analyzer's memory and can be displayed in one of the following four formats: software-smoothed, raw sample points, software interpolated, or binary.

1.4.6 Easy Analog Measurements

Waveform display manipulation is similar to that used by the timing analyzer. A moveable, inverse video graticule at the bottom of the CRT indicates the position and amount of waveform being displayed relative to the entire 1000-sample data collection. For closer inspection, any waveform section can be magnified up to 20 times. Also, any point on the waveform can be selected as the origin so you can directly read instantaneous voltage and time value differences as you sweep the cursor across the screen (see Figure 1-16).

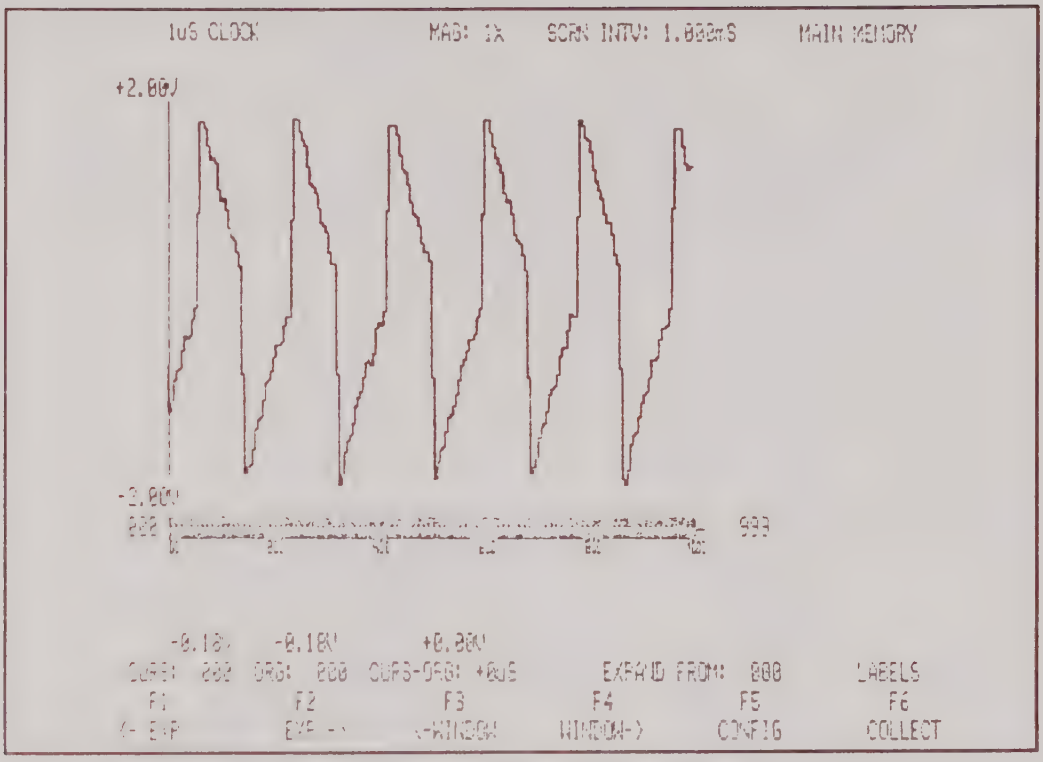

Figure 1-16. Typical Waveform Display

Similar to the state and timing analyzers, the waveform section allows you to store both the menu and a reference waveform for comparison testing. If you want permanent storage, the waveform and associated menu can be transferred to diskette. You can even label the waveform for easy identification when the test is later recalled.

1.4.7 Cross-Domain Analysis

Although the waveform analyzer is very useful as a stand-alone tool, its enormous debugging power becomes apparent when you link it to the state or timing sections of the NPC-800D. For example, when you need to examine closely the power-on characteristics of both the analog and digital portions of your system, you can set the waveform analyzer to trigger the state analyzer when the +15 volt power supply reaches a certain threshold. At this point, the NPC-800D simultaneously collects both the +15 volt signal and the associated power-up subroutine.

As a second example, you can use the state analyzer to trigger the waveform analyzer upon the occurrence of an I/O address. The waveform analyzer could then be used to monitor the output signal at a serial port, while the state analyzer is collecting the associated I/O subroutine.

1.4.8 Performance Monitoring

As hardware and software become more complex, the time your system takes to complete a given task becomes an important consideration. That's why the NPC-800's plug-in, counter-timer option is a useful performance monitoring tool during system test and integration.

1.4.9 Using Counter-Timer Plug-In

The counter-timer offers you a choice of four different modes of operation: FREQUENCY, PERIOD, INTERVAL, and TOTAL. For stand-alone operation, a single, scope-type probe allows you to make conventional counter-timer measurements at various points in your system (see Figure 1-17).

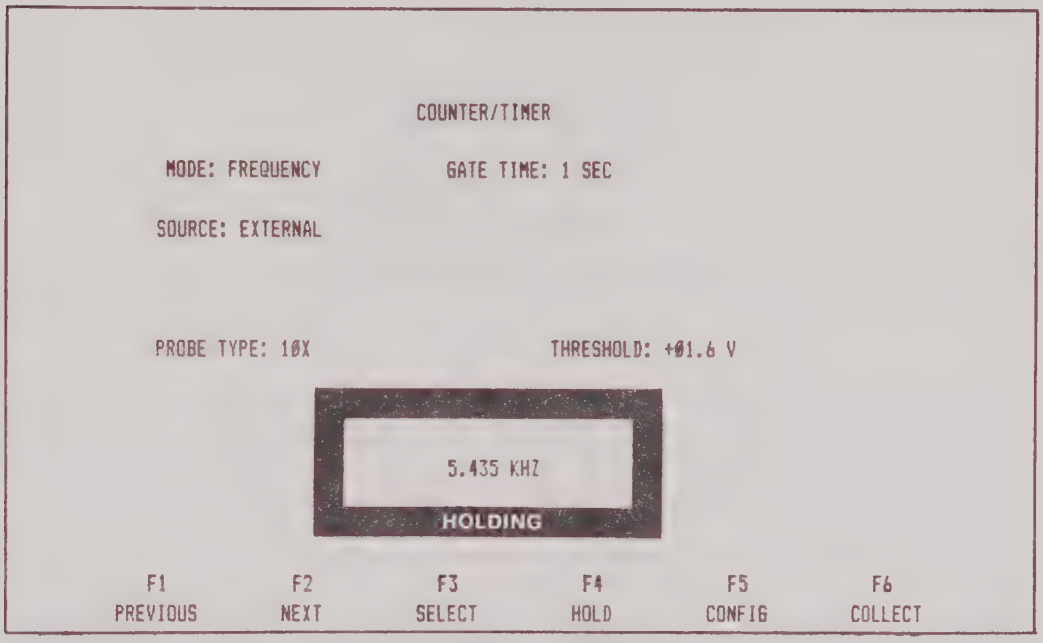

Figure 1-17. Typical Counter-Timer Menu

However, for more complex measurements, particularly those involving performance monitoring, the counter-timer can be linked to the state analyzer's word recognizers, allowing measurements to be made on the data coming into the three 16-channel state probes (see Figure 1-18).

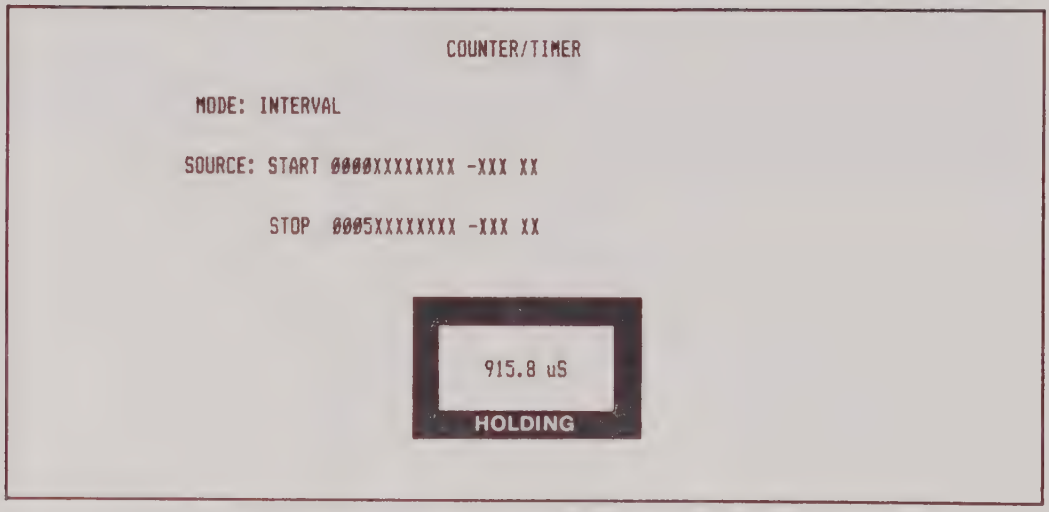

Figure 1-18. Measuring Interval Between Two State Events

Using this internal linkage mode, performance monitoring examples include measuring the frequency of occurrence or average period of a subroutine counting the total number of times a particular address or data word occurs during a program and determining the time elapsed during the execution of a particular segment of code.

1.4.10 Histograms

To be time and cost-effective analyzing system performance, NICOLET provides optional software that gives a graphic presentation of statistical information collected from the target system under test. Using the state analyzer and the counter-timer hardware capabilities, this graphic display, in bar chart format, allows a broad overview of the target system.

The optional histogram feature allows use of the state analyzer in conjunction with the counter-timer hardware. This software operates in two modes, Event Histograms or Time Interval Histograms.

To monitor the relative time consumption in the target system, the Event Histogram mode allows you to select up to eight different events. These events are specified by the user as eight ranges, (such as address ranges). Then, when the logic analyzer is started, the state analyzer processes its clock qualifiers and trigger events while collecting data. Once the logic analyzer has filled its memory with data, the Event Histogram software examines the data to determine whether any of the data fits within any of the specified event boundaries and accumulates the quantity of data words within each event. Then the logic analyzer collects another set of data, repeating data examination and accumulation of occurrences of specified events, each time ending the examination with a bar chart display depicting the relative amount of time spent within each event boundary by the target system. Because of an increasing statistical sample size, the longer the logic analyzer is allowed to monitor the target system the more accurate the histogram becomes (see Figure 1-19).

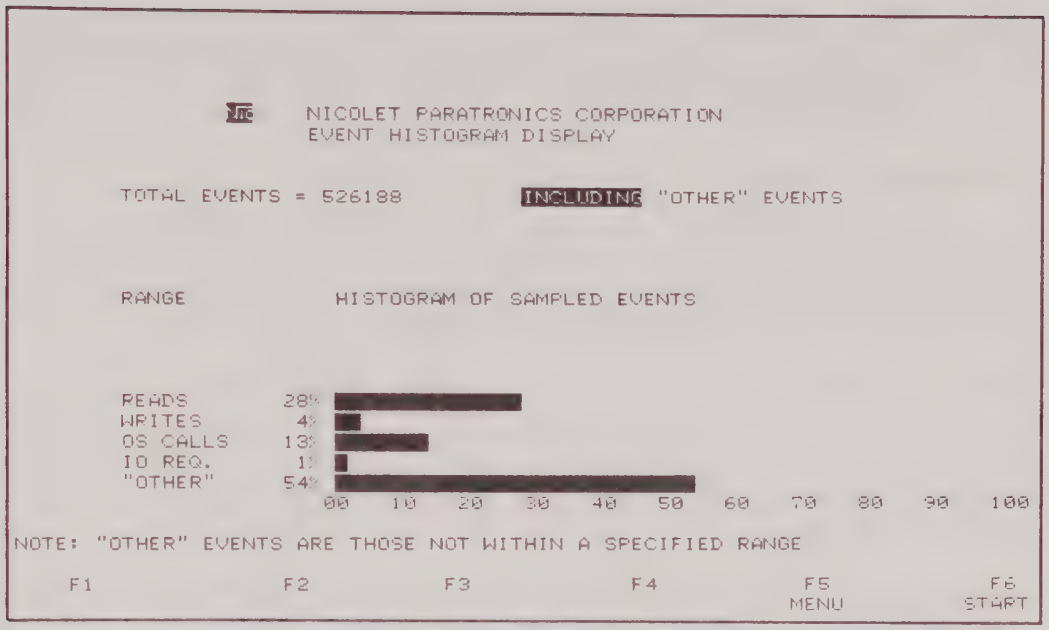

Figure 1-19. Event Histogram Bar Chart Display

The Time Interval Histogram software operates in a slightly different manner. The user specifies only one event, within a range of upper and lower boundaries. But this time the counter-timer measures the time interval between upper and lower boundary words. Therefore, the user also specifies up to eight ranges in time (see Figure 1-20). Then, at each occurrence of the specified event, the counter-timer measurement is compared to each of the eight ranges in time. The quantity of occurrences within each range in time is accumulated and displayed in bar chart format.

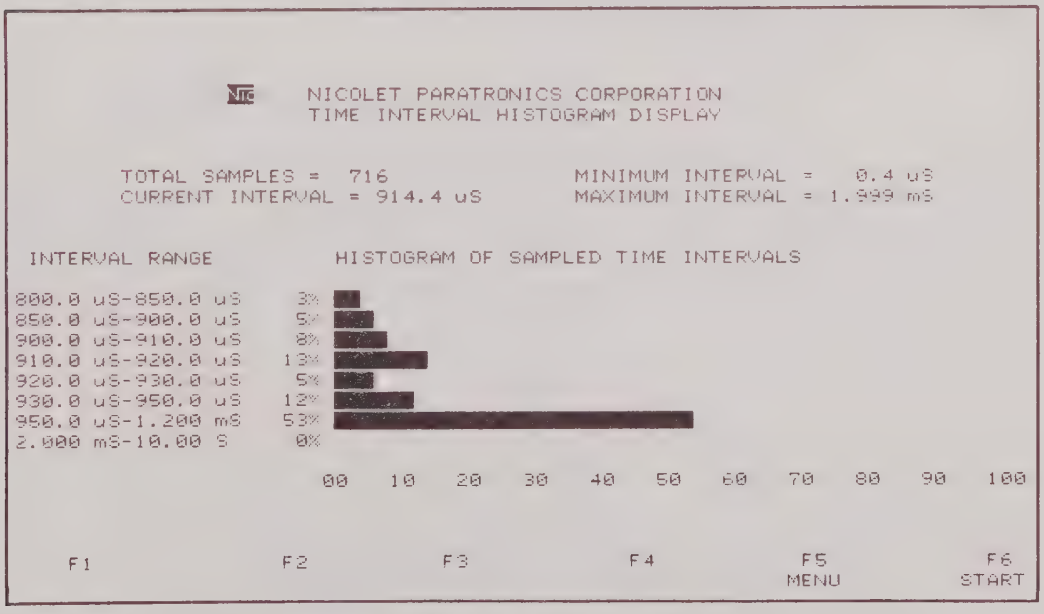

Figure 1-20. Time Interval Histogram Menu

Using the Event Histogram mode the NPC-800D provides an overview of the total performance of the target system. This mode also provides performance information on a single event within the target system, allowing the user to optimize software or hardware to achieve faster system operation.

1.4.11 Signature Analysis For Fault Isolation

The signature analyzer resides on the same plug-in board as the counter-timer. And like the counter timer, the signature analyzer can be linked to the state analyzer's word recognizers. This enables start and stop signals to be a minimum of one-bit wide, similar to conventional signature analyzers, or equal to the channel width of the state data probes.

Signature analyzers require a clock, a control gate signal, and a data input line.

The NPC-800D state analyzer's master clock serves as the clock for the signature analyzer. The 53 data and qualifier lines open and close the control gate with start and stop words, respectively. The data line is the input from the rear panel BNC Connector and uses the oscilloscope-type probe.

The signature is produced by the data being logically combined with the outputs of various stages of a 16-stage shift register. It is "residue" after closing of the gate.
With a one-bit start and stop signal, a single scope-type probe is used to monitor the serial data stream associated with each node in the circuit-under-test. This serial data stream, gated by the start and stop signal, is used to develop the four-digit signature (see Figure 1-21).

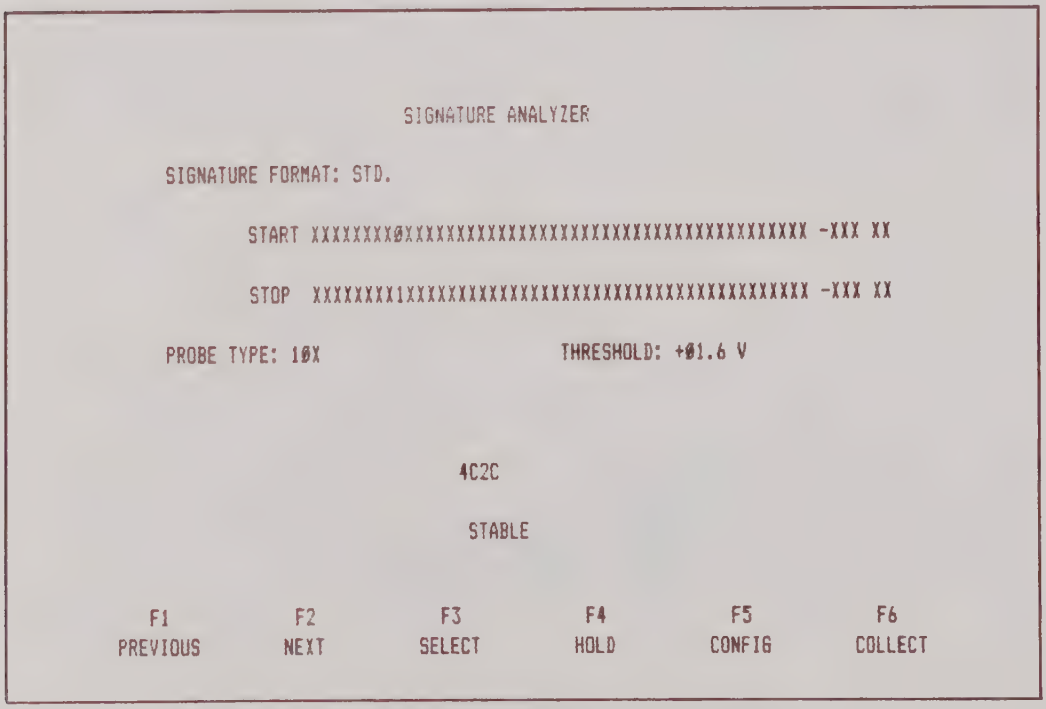

Figure 1-21. Simple One-Bit Signature Analyzer Menu

When the start and stop signal is more than one-bit wide, you can develop signatures of more complex events. For example, if the start word was a subroutine call address and the stop word was a subroutine exit address, a unique signature of that subroutine would be developed by using the LSB of the address as the input serial data stream. In this manner, software bugs or revisions can be readily identified (see Figure 1-22).

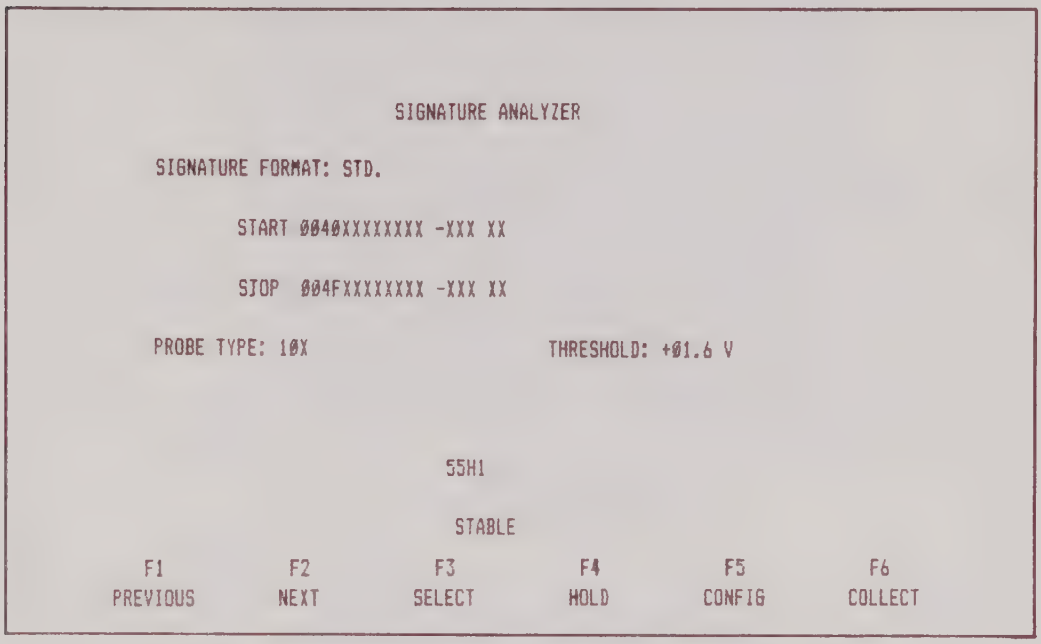

Figure 1-22. Signature Analyzer Menu For Developing Software Signatures

The algorithm that is used develops the same four-digit signature as other industry-standard signature analyzers. The signatures can be displayed in hexadecimal or in the industry standard format.

1.4.12 Model 70 For Bidirectional Serial Testing

In many applications, the ability to troubleshoot an RS-232 interface is an essential part of the system testing task. The Model 70 Serial Communications Probe is a cost-effective way of adding bidirectional serial testing capability to your NPC-800D. Simply insert the Model 70's TEE connector between your computer and its peripheral and use the NPC-800's state analyzer and Model 70 transmit menu to capture, analyze, edit and transmit serial information (see Figure 1-23).

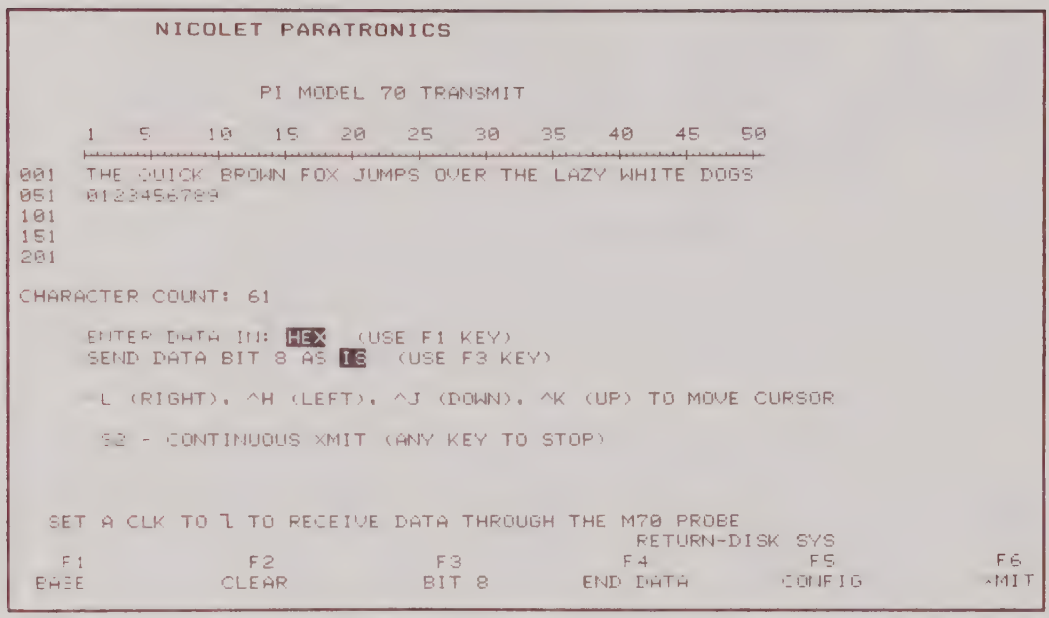
NICOLET PARATRONICS
PI MODEL 70 TRANSMIT
1 5 10 15 20 25 30 35 40 45 50
001 THE QUICK BROWN FOX JUMPS OVER THE LAZY WHITE DOGS
051 0123456789
101
151
201
CHARACTER COUNT: 61
ENTER DATA IN: HEX (USE F1 KEY)
SEND DATA BIT 8 AS IS (USE F3 KEY)
L (RIGHT), ^H (LEFT), ^J (DOWN), ^K (UP) TO MOVE CURSOR
S2 - CONTINUOUS XMIT (ANY KEY TO STOP)
SET A CLK TO 1 TO RECEIVE DATA THROUGH THE M70 PROBE
RETURN-DISK SYS
F1 BASE
F2 CLEAR
F3 BIT 8
F4 END DATA
F5 CONFIG
F6 XMIT

Figure 1-23. Model 70 Serial Transmit Menu

LED's on the Model 70 Serial Probe provide a real-time indication of the activity on the RECEIVE, TRANSMIT, and STATUS pins. Baud rates from 50 to 19.2k baud are switch-selectable on the probe. Other switches allow you to define pins 2 and 3 as RECEIVE or TRANSMIT, and to define the number of stop bits, parity, and word length (see Figure 1-24).

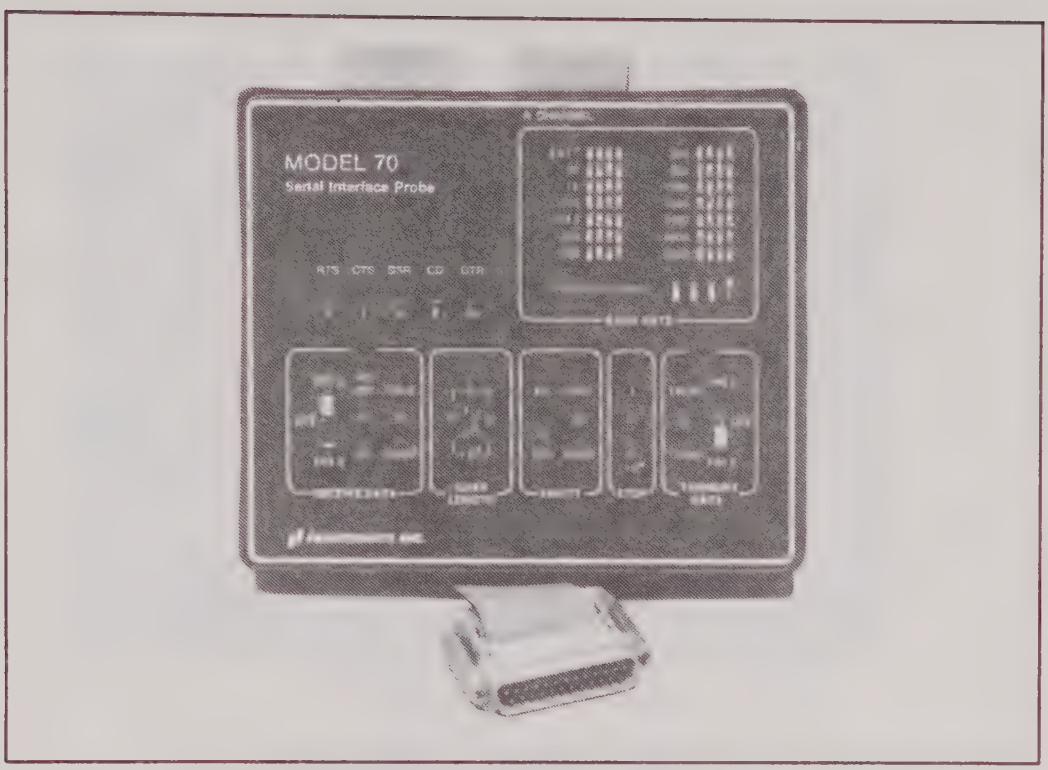

Figure 1-24. The Model 70 Serial Probe

The Model 70 Serial Probe only requires 16 state channels. Therefore, to support additional measurements in your system, there are 32 extra state channels, 16 timing channels, and other internal test functions.

As an example, assume you have a peripheral device that is not functioning properly. Is the problem in the computer, in the device, or in the interface itself? With the NPC-800D/Model 70 combination, you have all the resources you need to rapidly isolate the problem. Use the RECEIVE and TRANSMIT modes to identify the computer, the peripheral, or the interface as the source of the problem.

1.4.13 Eight-Bit and 16-Bit Dedicated Microprocessor Probes For Fast Software Debug

As the software used in system design grows, a logic analyzer and a dedicated probe with real-time disassembly capabilities become invaluable tools for analysis and debug. Real-time disassembly gives the user the ability to look at software execution at full system speeds. The data collected are then displayed in easy-to-read assembly language mnemonics.

1.4.14 Quick Connection

Using a pre-wired IC clip, each dedicated probe offers quick, Where space is a problem, a low-profile "piggy-back" socket is also available.

All necessary signals for clocking data into the NPC-800D are automatically generated by circuitry inside the probe. Data collection includes address, data, control and status lines. One example of a dedicated probe is shown in Figure 1-25.

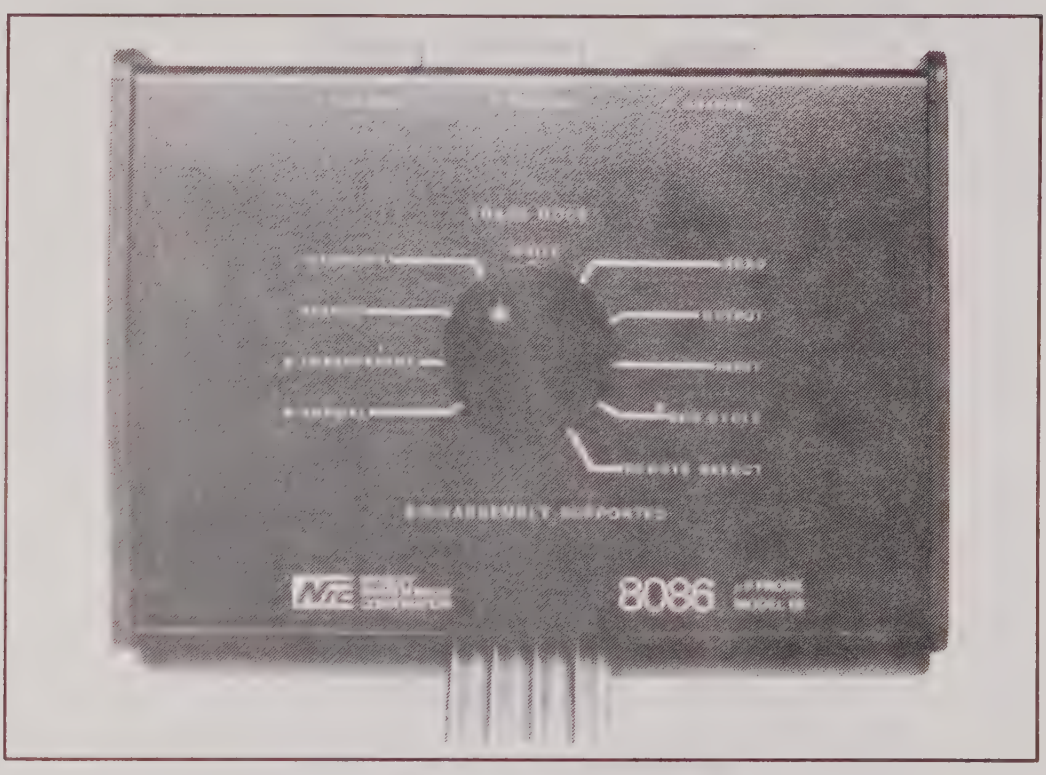

Figure 1-25. Dedicated Probe for the 8086

1.4.15 Powerful Analysis Capabilities

Used in conjunction with the dedicated probes, the NPC-800D's powerful clock and trigger qualifiers can simplify the analysis of your program's execution. With these qualifiers you can collect specific MPU operations or a combination of operations from among the following: MEMORY READ/WRITE, I/O, OPCODE FETCH, MPU STACK READ/WRITE, or BRANCHES (see Figure 1-26).

```
MAIN              000   0000          F3       OPCODE FETCH(TAIL)
                  001   0000          FF       REFRESH
LOC: TRIG         002   0001    JP            0040H
                  003   0001          FF       REFRESH
SIG: E3D7         004   0002          40       OPERAND FETCH
     36E5         005   0003          00       OPERAND FETCH
     D8D3         006   0040    LD            SP,23FCH
                  007   0002          FF       REFRESH
                  008   0041          FC       OPERAND FETCH
                  009   0042          23       OPERAND FETCH
                  010   0043    LD            IY,00A0H
                  011   0003          FF       REFRESH
                  012   0044          21       OPCODE FETCH(TAIL)
                  013   0004          FF       REFRESH
                  014   0045          A0       OPERAND FETCH
                  015   0046          00       OPERAND FETCH
                  016   0047    SET           7,(IY+55H)
                  017   0005          FF       REFRESH
                  018   0048          CB       OPCODE FETCH(INCOMPLETE)
                  019   0006          FF       REFRESH
                  020   0049          55       OPERAND FETCH
                  021   004A          FE       OPCODE FETCH(TAIL)
                  022   00F5          21       DATA READ
```

Figure 1-26. Typical Disassembly

Also, unwanted microprocessor activities, such as WAIT states and REFRESH cycles, can be purged from the data collection. Once set up, all modes are switch-selectable at the probe and require no further changes to the NPC-800D's menu. Additional software analysis capabilities include triggering on one operation, such as a BRANCH, and collecting a different operation, such as memory READS.

In relation to the actual operands and memory addresses being generated, all of the NPC-800D's 8-bit and 16-bit dedicated probes allow true, real-time disassembly of instructions being executed. Furthermore, NPC's dedicated probes are not intrusive to the MPU's operation; they do not interfere with real-time operation of the target MPU.

1.4.16 Advanced Analysis Capabilities

Depending on probe type, NPC's dedicated probes require 32 to 48 state channels. As shown below, this leaves the remaining channels and test functions for an in-depth analysis of events on or off the microprocessor bus:

Dedicated Probe Type*	Channels Required by Probe	Logic Analysis Channels Remaining
8080, 8085, Z80, 6809, 6809E, 6800, 6802 M71	32 State	16 Timing plus 16 State
8086 8088 68000 General Purpose	48 State	16 Timing

For example, assume you are using the timing section to monitor a hardware interrupt subsystem and the state section to monitor the MPU. By linking the two sections, you can capture the interrupts while simultaneously disassembling the associated interrupt handling subroutine.

*Contact Nicolet Paratronics Corporation for the availability of dedicated probes not listed.

1.4.17 NPC-800D — A General-Purpose Computer

The NPC-800D departs from conventional test equipment by giving you full access to its internal microcomputer for automatic control, test storage, post-processing, and general-purpose computing applications.

The NPC-800D uses an 8085 CPU and two operating systems: one operating system is in ROM and supports all test and measurement functions; the other optional operating system, CP/M, resides on disk and supports all computer-related activities. These two operating systems are designed to interact during automatic testing, test storage, and post-processing of collected data.

Each stored test can incorporate comments, instructions, and other pertinent information. For example, in an engineering lab application, test comments could include date of test, name of engineer, test or probing procedures, and remarks. On the production line or in the field, step-by-step procedures can accompany stored tests to increase the productivity of test personnel.

```
A>ed autotest.sub
: *i
1: ;
2: ;  TO THE OPERATOR:  YOU'RE GOING TO PERFORM 3 TESTS.
3: ;  IT'S IMPORTANT THAT YOU FOLLOW THE INSTRUCTIONS CAREFULLY.
4: ;
5: ;  STATE TEST:  AFTER READING THE INSTRUCTIONS BELOW, PRESS RETURN
6: ;              WHEN THE CURSOR FLASHES.  THIS WILL CALL THE STATE TEST
7: ;
8: ;  A. CONNECT THE A STATE PROBE TO THE A SIDE OF THE TEST CARD.
9: ;  B. WHEN THE CONFIGURATION LIST APPEARS, PRESS THE COLLECT KEY.
10: ;  C. AFTER THE TEST IS COMPLETE, PRESS THE CONFIG KEY FOLLOWED BY THE
11:        ESC KEY TO RECEIVE INSTRUCTIONS FOR THE NEXT TEST.
12:
13: ;  REMEMBER, PRESS RETURN WHEN THE CURSOR FLASHES.
14: PAUSE
15: LABECALL STATE
16: ;
17: ;  TIMING TEST
18: ;
19: ;  A. CONNECT THE B TIMING PROBE TO THE B SIDE OF THE TEST CARD.
20: ;  B. WHEN THE CONFIGURATION LIST APPEARS, PRESS THE COLLECT KEY.
21: ;  C. AFTER THE TEST IS COMPLETE, PRESS THE CONFIG KEY FOLLOWED BY THE
22:        ESC KEY TO RECEIVE INSTRUCTIONS FOR THE NEXT TEST.
23: ;
24: PAUSE
25: LABECALL TIMING
26: ;
27: ;  WAVEFORM TEST (OPTIONAL)
28: ;
29: ;  A.  CONNECT THE SCOPE PROBE TO THE HP TESTPOINT ON THE TEST CARD.
30: ;  B.  AFTER THE CONFIGURATION LIST APPEARS, PRESS THE COLLECT KEY.
31: ;  C.  THIS COMPLETES THE TEST SERIES.
32: PAUSE
33: LABECALL WAVE
34:
35: ; *E
36: ▌
```

Figure 1-27. Simple Automated Test Program With Operator Prompts, Using Computer Option

```
A>dir
A: PIP      COM : XSUB     COM : ED       COM : ASM      COM
A: DDT      COM : LOAD     COM : STAT     COM : DUMP     COM
A: SUBMIT   COM : EPSON    BAK : EPSON    PRN : CRUN23   COM
A: FORMAT1  COM : GPIBEX80 COM : LARECALL COM : UC2      COM
A: LASAVE   COM : LADISA   COM : EPSON    HEX : LA       COM
A: SAVREC   COM : CRUN2    COM : CBAS     COM : XREF     COM
A: GPIBPS80 MAC : SAVREC80 MAC : GPIBPS80 REL : GPIBEX80 REL
A: SAVREC80 REL : SAVREC   ASM : GPIBEX   INT : GPIBEX80 BAS
A: LADISC80 BAS : GPIBEX   BAS : GPIB80   BAS : GPIB     BAS
A: LADISC   BAS : RS232EX  BAS : RS232EX  001 : EPSON    ASM
A: D6800        : D68000       : D8085        : RS232EX  INT
A: DZ80         : D6809E       : D488         : D8080
A: D8086        : UC2      LST : 68000    DAT : TERMINAL COM
A: 6809E    DAT : Z80      DAT : 8080     DAT : 8085     DAT
A: 8086     DAT : 6800     DAT : IEEE488  DAT : XFER     COM
A: INTRP    INT : INTRP    BAS : FORMAT2  COM
```

Figure 1-28. Typical CP/M Diskette Directory (your listing may differ)

1.4.18 System Architecture

The NPC-800D incorporates a bus-oriented microcomputer architecture. Internal 8085 CPU, CRT, keyboard, memory and I/O subsystems, as well as the logic analyzer and other measurement functions, all interface to the CPU bus as shown in Figure 1-3.

Since the analyzer's control programs are contained in 48k of ROM, all test and measurement functions are totally independent of the CP/M operating system and the disk drive.

In contrast, all general-purpose computing tasks use the integral disk drive and the CP/M operating system as the primary interface. As shown in the figure, for execution, programs are downloaded into 48k of user RAM. It's important to note that this user RAM is separate from the real-time data acquisition memories associated with the state and timing analyzers.

The 9-inch CRT display is memory-mapped and uses an 80-character by 25-line format. A 256-character display generator provides full ASCII and graphics character sets.

1.4.19 CP/M Enhancement

Although there are hundreds of reasonably priced applications programs on the market offering higher level languages, engineering and scientific packages - even word processing, CP/M was chosen for the NPC-800D because it is the single most commonly used operating system.

Through CP/M, the user can also generate his or her own programs. These programs can be written in assembly language or such high-level-languages as CBASIC*, FORTRAN, PASCAL, or PL/1.

A printer driver program is available that enables the NPC-800D to provide both text and graphics hardcopy on Epson dot-matrix printers. (Most of the illustrations in this manual were made using this program.)

In conjunction with its CP/M Operating System, the NPC-800D's computer option allows you to perform the following:

- Automatically execute a series of stored tests using simple CP/M commands or the built-in GPIB CONTROLLER. Standard IEEE-488 commands in CBASIC permit automation of internal test functions as well as control of external GPIB instruments.

- Execute commercially available CP/M application programs for solving engineering equations, circuit simulation, and report generation; even before hardware and software have been developed.

- Generate programs in CBASIC, FORTRAN, PASCAL, and other high-level languages to support your particular application. CBASIC is included at no cost with your computer option.

- Construct a low-cost, universal development system. Commercially available compilers and assemblers, and in-circuit emulators add software development capabilities to the NPC-800D.

1.4.20 Post-Processing Analyzer Data

Prior to the NPC-764 and NPC-800 Series, the logic analyzer user had to be satisfied with whatever data manipulation and display modes the manufacturer provided. However, through CP/M, post-processing programs can be written to support special applications. These programs can be generated in assembly language, CBASIC,* or other languages.

As a simple example, an applications program can be written to transfer previously collected data between the NPC-800D's state and timing sections. In this manner, you can display data collected by the state analyzer in a timing diagram format; or you can display state and timing data side-by-side on the same screen in the state format of your choice. Other post-processing examples include searching for certain patterns or sequences in the data collection, generating custom or nonstandard data displays such as histograms, and implementing special algorithms such as computing the Fourier transform of a previously-digitized analog waveform.

The commands that allow transferring of data between various analyzer memories and the 48k of user RAM are an integral part of the standard, NPC-800D I/O software described in the following pages. Besides allowing the manipulation of data within the NPC-800D, these commands also enable you to transfer normal or post-processed data to external GPIB or RS-232 devices.

1.4.21 The NPC-800D — A Low-Cost Development System

During the hardware and software integration phase of a project, a logic analyzer can be indispensable for uncovering subtle bugs. If the bugs are hardware-related, they can generally be fixed on the spot. However, if they are software-related, you may have to save up (and work around) enough bugs to make it worthwhile to halt the integration process and go back to the main development system to generate corrected code. By adding a stand-alone emulator and a PROM programmer to your NPC-800D (equipped with the computer option), software bugs can be fixed as they occur. This can be a more efficient and effective way to perform software integration since the debugging process can proceed without the delays often associated with having to access the main development system. Both the emulator and the PROM programmer interface to the NPC-800D's RS-232 port.

With the above set-up, software changes can be quickly implemented and tested in your system. When the changes are successful, new PROMs can be programmed.

*CBASIC is included with each computer option.

1.4.22 Automated Testing and Remote Control

A unique I/O software package, which allows the NPC-800D to be a central part of a powerful IEEE-488 automated test system, permits RS-232 MASTER/SLAVE operation in remote control applications. Additionally, the I/O software allows you to readily place the NPC-800D under the control of another computer.

1.4.23 Single I/O Menu Speeds GPIB and RS-232 Setups

The I/O software, which is an integral part of the ROM-based test and measurement operating system, does not require the CP/M operating system during manual operation. The associated I/O CONFIGURATION MENU incorporates all of the fields necessary to manually set up the NPC-800D for GPIB and RS-232 operation. The menu consists of four quadrants: GPIB, RS-232, INPUTS, and OUTPUTS (see Figure 1-29).

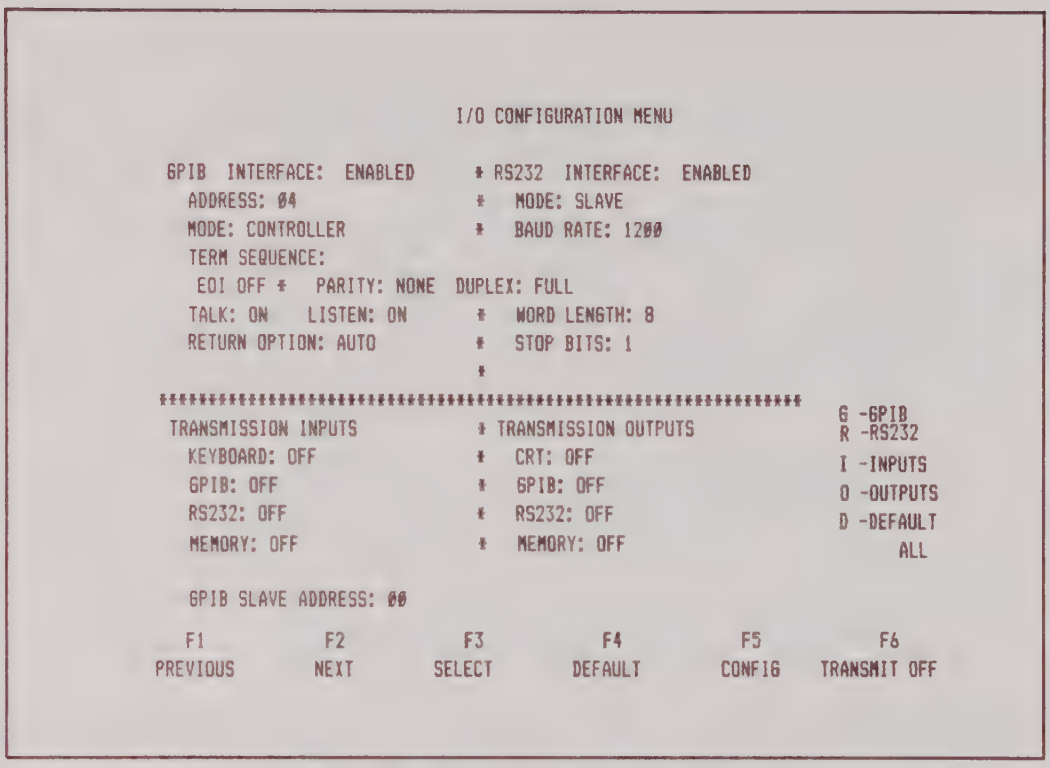

Figure 1-29. Default I/O Configuration Menu

On the GPIB quadrant of the I/O Configuration Menu, the NPC-800D can be set up as a CONTROLLER or a LISTENER/TALKER. On the RS-232 quadrant the instrument can be a MASTER or a SLAVE. In the TRANSMISSION INPUTS quadrant, data can come from the keyboard, from GPIB or RS-232 ports, or from various analyzer memories. Then, using the TRANSMISSION OUTPUTS quadrant, you can send data to the CRT, to various analyzer data memories, or out the GPIB or RS-232 ports. As a simple example of the use of the I/O CONFIGURATION MENU, consider an automatic test application that exercises an RS-232 or a GPIB device before running it under program control. By defining the NPC-800D's keyboard as the data input, and the NPC-800D's CRT as the output from the device under test, you can rapidly verify the integrity of your setup.

1.4.24 GPIB Controller/Device Applications

When the NPC-800D is the central part of a GPIB-based, automated test system, the CP/M operating system, hosting CBASIC, is employed. These are typical GPIB commands:

ABORT	REQUEST	LOCAL LOCKOUT
GPIB	OUTPUT	CONFIGURE
RESET	ENTER	EOI STATUS
REMOTE	STATUS	SENDBUS
LOCAL	SET TIMEOUT	TERM SEQ
TRIGGER		

When using these commands, it's important to note that the NPC-800D's internal test and measurement functions respond as if they were external devices on the GPIB bus.

Thus, you can add a pattern generator, a DVM, a power supply, and other GPIB-compatible instruments to the NPC-800D and use the same command set for both internal and external functions.

If you already have an IEEE-488 controller, you can incorporate the NPC-800D into your GPIB test set-up as a powerful LISTENER/TALKER. In this configuration, the NPC-800D responds to standard GPIB commands from your controller, executes the required test, and transfers the results back again.

1.4.25 RS-232 Master/Slave Applications

Remote diagnosis is one new application area that is showing considerable promise. Using an ordinary terminal and a telephone line, a factory specialist can remotely control the entire operation of an NPC-800D. To avoid having to set up another communications link between the local and remote locations, any message typed at one location will appear on the CRT at the other location.

If the ordinary terminal is replaced by an intelligent terminal or a computer, then the NPC-800D's functions can be fully automated. In this application, a test can be downloaded to the NPC-800D and the results sent back to the intelligent terminal or computer for processing.

A third possible I/O configuration: use one NPC-800D as a MASTER and a second NPC-800D as a SLAVE. Here, the NPC-800D functioning as the MASTER can execute a test on System A while the SLAVE NPC-800D, following the commands of the MASTER, is running a test on System B. The MASTER can then command the SLAVE to report its test results. (One of the example programs provided with your NPC-800D computer option actually performs this MASTER/SLAVE application.)

1.4.26 The NPC-800D — An Electronic Workbench

The table below summarizes how the NPC-800D performs test and measurement tasks previously requiring a bench full of sophisticated and expensive test gear.

Table 1-1. The Nicolet 800 Series Configuration Guide.

Function	NPC-800A	NPC-800B	NPC-800C	NPC-800D	NPC-800E
State Analyzer					
State Channels	32	48	48	48	
Clocking Speed	15MHz	15MHz	15MHz	25MHz	
Timing Analyzer					
Timing Channels	16	16	16	16	16
Max. Sampling Speed	100MHz	100MHz	200MHz	200MHz	200MHz
Options					
Non-Volatile Memory	Yes	Yes	Yes	Yes	Yes
Waveform Recorder	Yes	Yes	Yes	Yes	Yes
CT/SA	Yes	Yes	Yes	Yes	Yes
Second Disk Drive	Yes	Yes	Yes	Yes	Yes
Performance Analysis	Yes	Yes	Yes	Yes	Yes
Printer Software	Yes	Yes	Yes	Yes	Yes
Computer/Controller	Yes	Yes	Yes	Yes	Yes
Dot Matrix Printer	Yes	Yes	Yes	Yes	Yes

1.5 Basic Logic Analysis System Specifications

STATE ANALYZER:

Channels: 48
Inputs: 48 data, 3 clocks, 3 clock qualifiers, 3 data qualifiers, 1 external BNC qualifier, 1 link qualifier
Impedance: 44k ohms/15 pF
Threshold Adj.: ±6 V
Sense: TRUE OR COMP
Max. Input: ±25 V
Min. Input Swing: 0.5 V
Synch. Clock Rate: DC to 25 MHz
Min. Clock Width: 20 ns
No. of Clocks: 3 clocks, each with an independent qualifier.
Clock Qualifiers: Any 2 of 5, 53-bit words, logically OR'ed
Data Qualifiers: 5 (3 data qualifiers, 1 external BNC, 1 link)
Input Data:
  Setup—20 ns
  Hold-time—0 ns
Main State Memory: 48 X 1000
Aux. State Memory: 48 X 1000
Triggering:
  No. of Steps—8
Event Word—53 Bits wide
Event Sense—Choice of match or NOT match
  Delay Value (n)—0 to 9999
  Delay Modes—N clocks, N events
Hold ≠ Displays data when main memory differs from aux memory
State Linkage:
  Internal—Link state to timing. Link state to waveform
  External—BNC Link to any other NPC logic analyzer or external equipment
Event Status: State event progress displayed on CRT.
Test Codes (Sig): 3 four digit hex ID codes which represent data in memory using compression algorithm.
State Formats: Hex, octal, decimal, binary, ASCII, user defined combinations and mnemonics

Section 2
Preparation For Use

2.1 INTRODUCTION

This section provides precautions to observe during the initial installation of the NPC-800D. If you are a first time user of a Nicolet logic analyzer, it provides useful initial inspection, setup, interconnections, packaging and shipment information (should it ever need to be returned for calibration or service).

2.2 INITIAL INSPECTION

BEFORE OPENING SHIPPING CONTAINER, inspect outside of container for damage. If container is damaged, keep it until a damage inspection of the logic analyzer and its accessories has been completed. This container was designed to ensure that your instrument would arrive in good condition. It is recommended that you store the container so that it can be used should the instrument require service or return to Nicolet for the installation of other options.

If your logic analyzer is physically damaged, contact Nicolet, Digital Test Division immediately to arrange for repair or replacement. If container is also damaged, contact freight carrier.

Each NPC-800D receives a final inspection prior to shipment; a checklist identifies exactly what the shipment contains. Locate enclosed copy of checklist and confirm every item indicated on form has been received. If you cannot find the location of the items indicated, remember that some options are installed inside the analyzer; be sure to look inside the pocket of the accessory pouch.

To confirm that the NPC-800D is functioning properly, follow operating instructions (see Section 3).

2.3 PRECAUTIONS

2.3.1 Equipment Handling

The NPC-800D uses a modular construction in a rugged mechanical package. The operating environment temperature should be kept between 10° and 45°C (50° to 133°F). Also, do not use or store equipment in a dusty, smokey, or high static electricity areas. For the NPC-800D, as with other disk-based equipment, careful handling of diskettes and disk drive is recommended. Maximum temperature for a floppy disk is 104°F (40°C).

2.3.2 Programmable AC Voltage Selector Card

WARNING

1. BEFORE APPLYING POWER to the NPC-800D, make certain that programmable ac voltage selector card, which plugs into power module at rear of unit, is inserted in a position corresponding to the line voltage being used.

Also be sure PROPER FUSE IS INSTALLED. Correct fuse value for each voltage is printed on back of instrument, near fuse holder.

Otherwise, serious damage to internal switching power supply may occur.

2. DO NOT OPERATE this instrument WHEN THE TOP COVER IS REMOVED. Component failure may occur because of reduced cooling.

3. All service, other than that detailed in Section 2.3.5 should be performed only by trained maintenance personnel.

CAUTION

Failure to keep fan filter clean will result in excessive heat generation and equipment malfunction which may void your warranty.

Voltage selector card, shown in Figure 2-1, has three nominal voltage options: 100V, 115V, and 230V. The line voltage selected is visible without removing the card.

If it is necessary to change the line voltage, carefully grasp card edge with a pair of long-nose pliers and reorient it so that the proper voltage appears with card fully inserted.

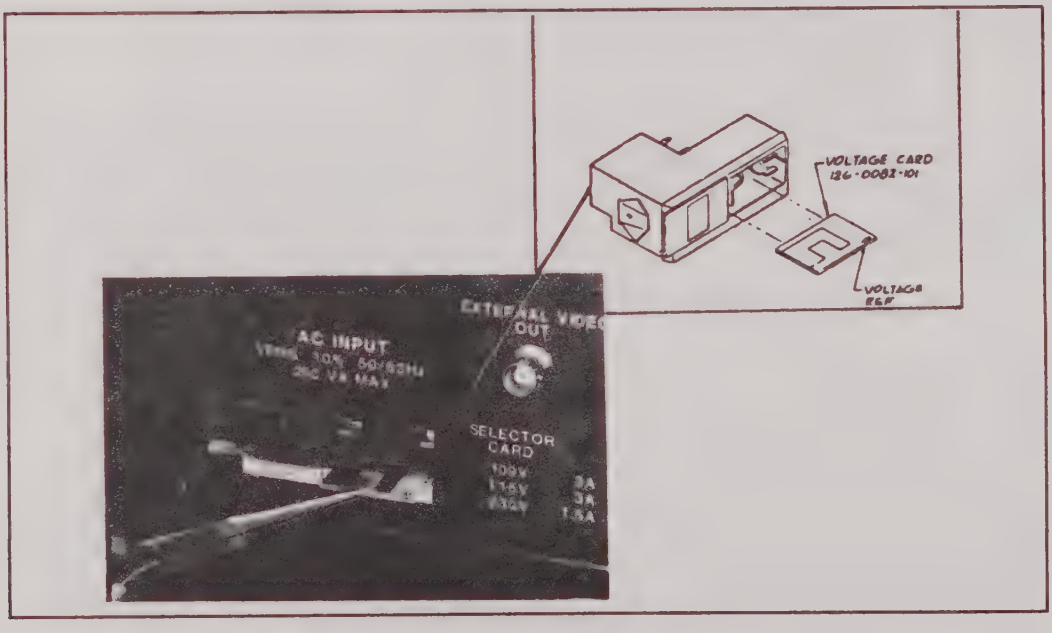

Figure 2-1. Programmable AC Voltage Selector

2.3.3 Handling of Diskettes

To protect the integrity of your data, menus, and programs, all diskettes should be handled with care. The following recommendations must be observed:

1. To avoid possible loss of information on the diskette, always unclamp and remove diskette from drive before NPC-800D power-up/down.

2. Return diskette to its storage envelope whenever it is removed from the disk drive.

3. Keep diskettes away from magnetic fields since exposure to such fields can affect data.

4. Do not write on plastic jacket with a lead pencil or ballpoint pen. Use a felt-tip pen or a stick-on label.

5. Smoke, heat and ashes from cigarettes can damage a disk.

6. Do not expose diskettes to heat or sunlight.

7. Never remove a diskette from its plastic jacket.

8. Do not touch or attempt to clean diskette surface because abrasions may cause loss of magnetized oxide and data.

9. Replace paper storage envelopes when they become worn, cracked, or distorted.

10. ALWAYS make a back-up copy of your diskette. ALWAYS buy good quality diskettes. They are worth the expense. Losing the only copy of a diskette, or losing a file because of accidental erasure, contamination, or poor quality media can be an expensive, and, possibly, an impossible situation to correct.

2.3.4 Write Protect Feature and Orientation

The WRITE PROTECT notch, when covered, protects the contents of the diskette from accidental alteration. A microswitch detects the presence or absence of a notch in the side of the diskette. When the open notch is sensed, writing is allowed. When the notch is not sensed (covered with a tab), writing is inhibited and a status signal informs the disk controller that a WRITE PROTECT condition exists.

2.3.5 Technical Assistance

Nicolet, Digital Test Division's applications and service engineers are available should you need assistance with your instrument.

In Massachusetts, Maine, Connecticut, Rhode Island, and New Hampshire call 617-664-0355.
In California call 415-490-8300.
Elsewhere in the USA call 800-NICOLET (800-642-6538)
Outside the USA, call your nearest Nicolet, Digital Test Division Sales office.

2.4 INITIAL SET-UP

BEFORE APPLYING POWER to the NPC-800D, make certain that the Programmable AC Voltage Selector Card, which plugs into power module at rear of unit, is inserted in the position corresponding to the line voltage being used.

Also make certain that the PROPER FUSE IS INSTALLED. The correct fuse value for each voltage is printed on the back of the instrument, near the fuse holder. Otherwise, serious damage to the internal switching power supply may occur.

Install AC Power Card and turn on Power Switch, which is located on the side of the analyzer. Wait approximately 30 seconds for CRT to warm-up. A display of the Configuration List should appear on the CRT.

2.4.1 Screen Adjustment

To adjust CRT screen brightness and contrast, use the following procedure:

1. As an alternate way to obtain the CONFIGURATION LIST, press red RESET key for approximately two seconds. Then press F1 key labeled STATE to display state menu.

2. To accommodate ambient lighting conditions, adjust BRIGHTNESS and CONTRAST controls located at left of CRT. Make sure adjustments provide adequate contrast between half-intensity and full-intensity characters.

2.4.2 CRT Frame Rate Selection/50 Hz - 60 Hz

If CRT display appears shifted up or down, it is probably because setting of CRT FRAME RATE switch on Processor Board does not correspond to line frequency being used. Figure 2-2 shows location and settings of CRT FRAME RATE SELECT switch.

2.4.3 Frame Rate Select Switch

The dip switch is accessed by first switching off the ac power. Then remove top cover by loosening the two quarter-turn fasteners on rear of cover. Notice that card cage hold-down strap may have to be removed to change switch setting. Turn ac power on to check frame positioning. Reverse setting of S8, if necessary.

CRT Frame Rate Select	**S8**
50 Hz	OFF (Down)
60 Hz	ON (Up)

Figure 2-2. CRT FRAME RATE SELECT Switch On Processor Board

2.5 INTERCONNECTIONS

2.5.1 Input/Output Interface Ports

2.5.2 Probe Connections

The primary inputs to the logic analysis functions of the NPC-800D are the probe connectors located on left side of instrument (see Figure 2-3). These ports are bidirectional, allowing the user to not only acquire data to be saved in the high-speed RAM of the analyzer, but also to output stimulus or data to his system under test via a user-supplied interface (most probes are not bidirectional except for the Models M70 and M71).

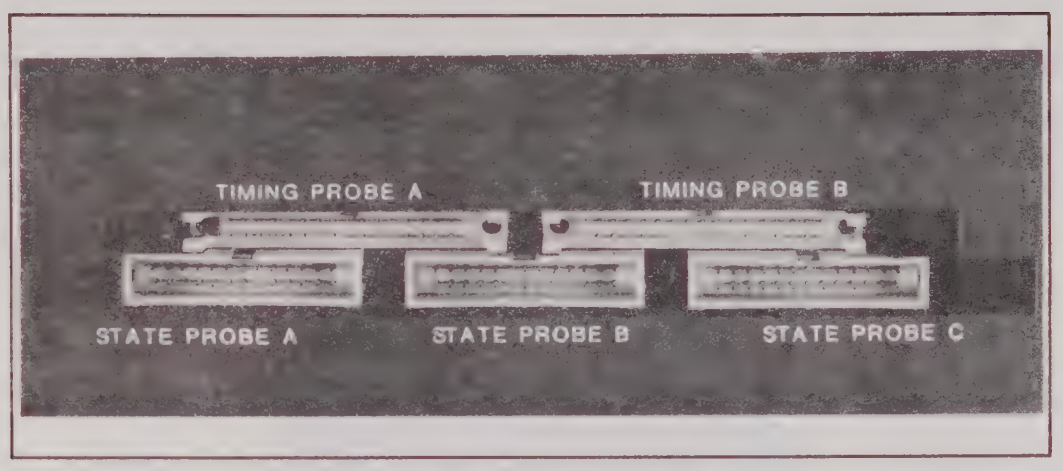

Figure 2-3. Probe Connections

2.5.3 External Video Out

This rear-panel BNC connector, shown in Figure 2-4, allows the NPC-800D user to display video information from the CRT on an external monitor. It can also be used to drive a video printer for hard copy documentation of menus and associated data. The output of this connector is a standard composite video. Its impedance is 75 ohms.

NOTE

The NPC-800D uses halflight reverse video in some menu fields. Certain video printers cannot reproduce these fields. To use these printers, short out 680-ohm voltage divider (R5) on top left portion of Processor Board (just below video connector). Use a shorting wire with miniature ball clips on both ends, or install a SPST switch. Remove short when printing displayed data.

2.5.4 RS-232C Serial Interface Port

As shown in Figure 2-4, the NPC-800D uses a standard EIA 25-pin connector to provide a bidirectional interface to RS-232C compatible devices (such as printers, PROM programmers, and emulators). Interface connection and internal switch settings are described in Section 3.20.6.

* RS-232C is included with the Nonvolatile Memory Option IEEE-488 CONNECTOR.

NOTE

An optional RS-232C software package for outputting text and graphics to an Epson printer is available. For details contact your local NPC sales office or the factory.

Included with each NPC-800D is a standard IEEE-488 (GPIB) interface. The NPC-800D is configured as a listener-talker device, unless the Computer/Controller option is also purchased. Paragraph 3.19.3 describes the operation of the NPC-800D on the bus.

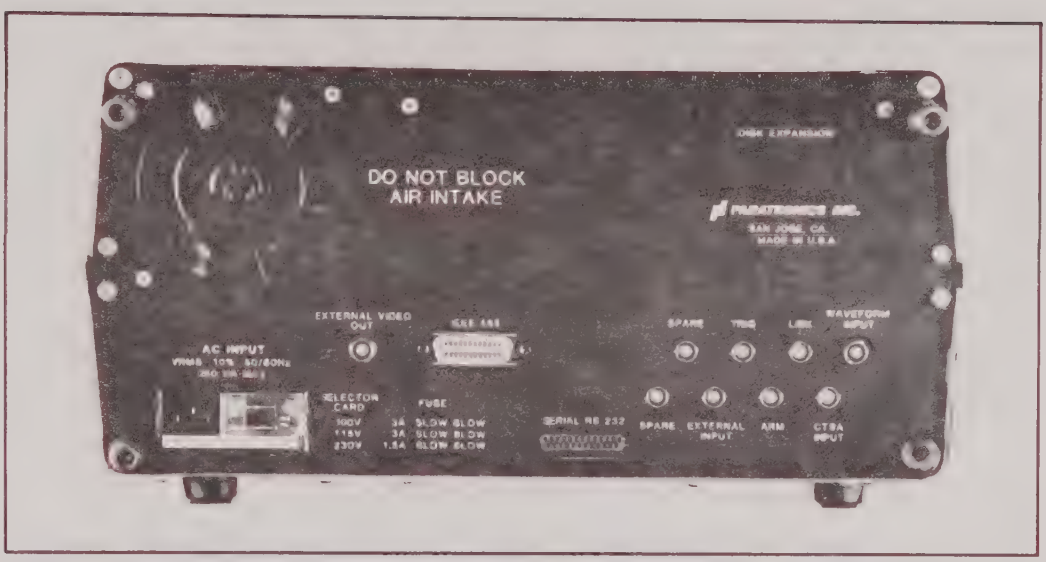

Figure 2-4. NPC-800D Rear Panel Connectors

There are several BNC connectors on the rear panel which provide inputs to various analysis functions or serve as outputs to external equipment such as an emulator or oscilloscope. They are as follows:

GND - Chassis ground terminal

WAVEFORM INPUT - Signal input to Analog Waveform Recorder option

CTSA INPUT - Signal input to Frequency Counter/Interval Timer/Signature Analyzer option

LINK - Bidirectional gate to send or receive a trigger signal to/from logic analyzer

ARM - Output from state logic analyzer trigger circuitry

TRIG - Output from timing logic analyzer trigger circuitry

EXTERNAL INPUT - Signal input to state and timing analyzer's event qualification circuitry

SPARE - Two unused connectors

To allow up to two more external disk drives to be added to the system, there is also a DISK EXPANSION connector.

2.6 PACKAGING FOR SHIPMENT

YOU ARE RESPONSIBLE FOR DAMAGE TO THE NPC-800D WHILE IT IS BEING RETURNED TO NICOLET, DIGITAL TEST DIVISION. Therefore it is recommended that you use the original shipping container any time your instrument must be shipped. If you cannot locate original container, advise Nicolet, Digital Test Division and another will be sent to you. If you cannot use the container supplied by Nicolet, you must use a strong carton with a shock absorbing material surrounding the instrument, approximately 3-inches thick on all sides.

Before shipping your instrument to Nicolet, Digital Test Division, PLEASE RECORD THE FOLLOWING INFORMATION:

Company Name:
Address:
Technical Contact:
Phone Number:
Purchasing Contact:
Phone Number:
Purchase Order Number:

Model Number:
Serial Number:
Software Revision:
List of Accessories Returned:

Brief description of the failure (or work to be performed).

Then contact Nicolet to get authorization to return the instrument for service or other work. An example would be an option installation. Nicolet will provide you with a Return Material Authorization number. It will help expedite service to your instrument.

Nicolet can provide you with an estimate for repair charges prior to shipment to Nicolet. If you include a purchase order for that amount, it usually speeds up total repair time. If our estimate was too high, we invoice you only for actual charges. If our estimate was too low, we will contact you for permission to exceed the estimated charges.

2.7 SHIPMENT

Nicolet, Digital Test Division has had good experiences with most of the popular freight carriers. HOWEVER, THE INSTRUMENT MUST BE PACKAGED PROPERLY.

If your instrument is still in warranty, you pay for shipment to Nicolet. Nicolet will pay the freight charges back to you.

If your instrument is out of warranty, Nicolet will pre-pay the freight charges, but will invoice you for that amount, along with the repair charges.

Section 3
Operation

3.1 INTRODUCTION

3.1.1 Menus and Displays

The power and ease-of-use of the NPC-800D Logic Analysis System results from the straightforward interaction of each menu with the keyboard. In fact, much of this section of the Operator's Manual is contained in the software which directs the user to the proper keystroke sequence. In general, keyboard entry of commands or data follows these basic guidelines:

1. The information displayed is always the current state of the analyzer.

2. Parameters that can be modified by the user are identified on the video display screen by a half-lit inverse video field.

3. Keyboard entries are placed into the menu at the position identified by a blinking cursor.

4. To move the cursor from one field to the next, use the PREVIOUS and NEXT keys.

5. To move the cursor within a field, use the SPACE BAR and BACKSPACE keys.

6. When some menus are displayed, F3 and F4 are labeled at the bottom of the CRT as SELECT and DEFAULT, respectively. Pressing SELECT causes each of the available options for that field to be selected. This simplifies the specification of some parameters and allows the user to scroll through all options to select the one most appropriate. Depending on the field, DEFAULT returns the field to the power-on condition or moves the cursor to the beginning of the field.

7. For immediate movement between a data display and its related setup menu, DIRECT keys may be used as follows:

State: P displays the program setup menu
Q displays the clock qualifier, event setup menu

Timing: C displays the timing setup, cursor at CLOCK field
A displays the timing setup, cursor at ARM field
T displays the timing setup, cursor at TRIGGER field
P displays the timing setup, cursor at PRETRIGGER field
D displays the timing setup, cursor at the DISPLAY ORDER field

From setup, S1 & S2 display the data in memory without acquiring new data.

8. If an attempt is made to set up an illegal condition, an error message (in English) flashes on the CRT indicating which keys are appropriate for the current field.

9. In most data entry fields, pressing the ? key displays a prompting message on the screen indicating the type of data or commands that can be entered into the current field.

3.1.2 Analysis Examples

The NPC-800D was designed for ease-of-use. Upon application of power, the Analyzer's ROM-based operating system displays the CONFIGURATION LIST illustrated in Figure 3-1.

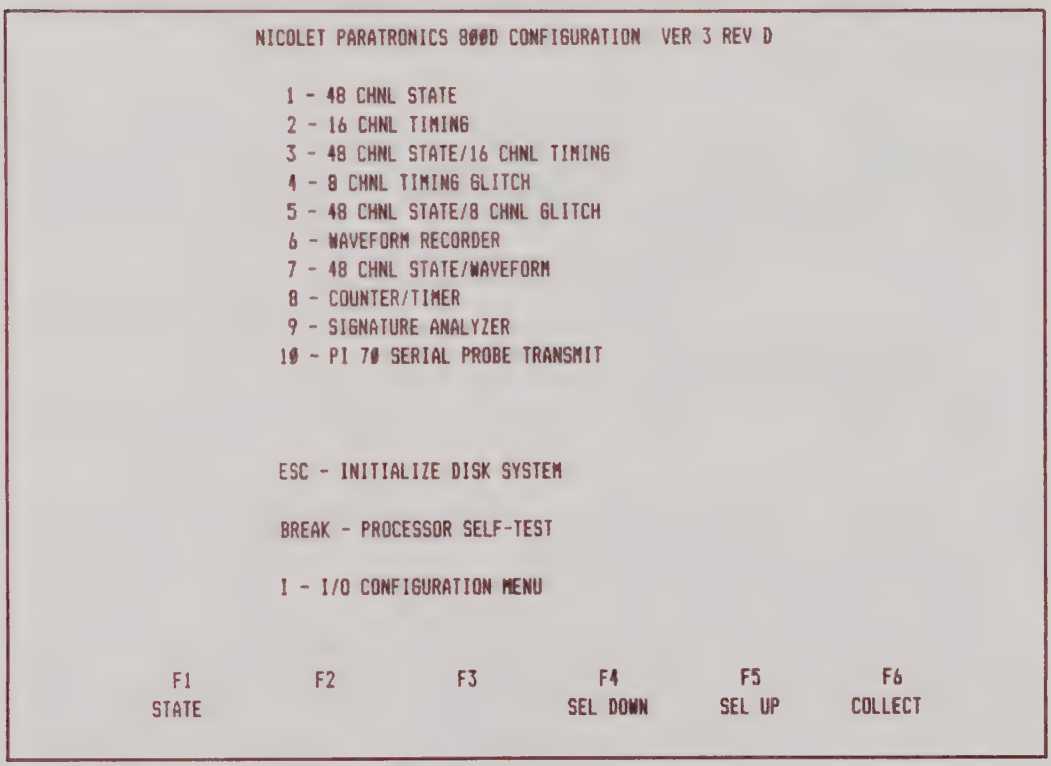
NICOLET PARATRONICS 800D CONFIGURATION VER 3 REV D
1 - 48 CHNL STATE
2 - 16 CHNL TIMING
3 - 48 CHNL STATE/16 CHNL TIMING
4 - 8 CHNL TIMING GLITCH
5 - 48 CHNL STATE/8 CHNL GLITCH
6 - WAVEFORM RECORDER
7 - 48 CHNL STATE/WAVEFORM
8 - COUNTER/TIMER
9 - SIGNATURE ANALYZER
10 - PI 70 SERIAL PROBE TRANSMIT
ESC - INITIALIZE DISK SYSTEM
BREAK - PROCESSOR SELF-TEST
I - I/O CONFIGURATION MENU
F1 STATE
F2
F3
F4 SEL DOWN
F5 SEL UP
F6 COLLECT

Figure 3-1. Configuration List

The Logic Analyzer Test Card, included with each NPC-800D, provides a known stimulus to the analyzer so that a given test setup results in a predictable response.

If you have any questions, please feel free to call Nicolet Digital Test Divisions Applications Engineers at the following locations:

- In Massachusetts, Maine, Connecticut, Rhode Island, and New Hampshire, call 617-664-0355.
- In California, call 415-490-8300.
- Elsewhere in the USA, call 800-NICOLET (800-642-6538).
- Outside the USA, call your nearest Nicolet Digital Test Division Sales office.

3.1.3 Function Keys

The six "soft" function keys labeled F1 to F6, from left to right, are identified by labels on the bottom line of the CRT. Their functions differ from menu to menu, but as the display changes their label on the CRT changes also.

3.1.4 Test Card Description

The logic analyzer test card is provided to allow you and your co-workers to rapidly familiarize yourselves with the basic and advanced features of the instrument.

The logic analyzer test card consists of two 8-bit CMOS counters (A and B), a clock, and simple decoding logic (see Figure 3-2). Each CMOS counter normally counts from (00)HEX to (FF)HEX. When the A counter reaches (40)HEX, the decode logic resets the B counter to (00)HEX.

The test card's A channel connector is wired so that the 8 **least** significant bits toggle in a sequential fashion; while the 8 **most** significant bits are tied to ground. Therefore, the A channel connector provides a 16-bit word which covers the range from (0000)HEX to (00FF)HEX.

The test card's B channel connector is wired so that its 16 output bits toggle nonsequentially. The following is a typical binary count sequence at the B channel connector:

COUNT	BINARY PATTERN*	HEX PATTERN
0	00000000 00000000	00 00
1	10000000 00000001	80 01
2	01000000 00000010	40 02
3	11000000 00000011	C0 03
"	" "	" "
"	" "	" "
"	" "	" "
15	11110000 00001111	F0 0F

Power to the test card is supplied by the +5V output at each probe connector.

*The A connector is generally used as a signal source for one state or timing probe; the B counter output feeds the second state or timing probe. For the NPC-800D, the third 16-channel state probe is not normally connected to the test card.

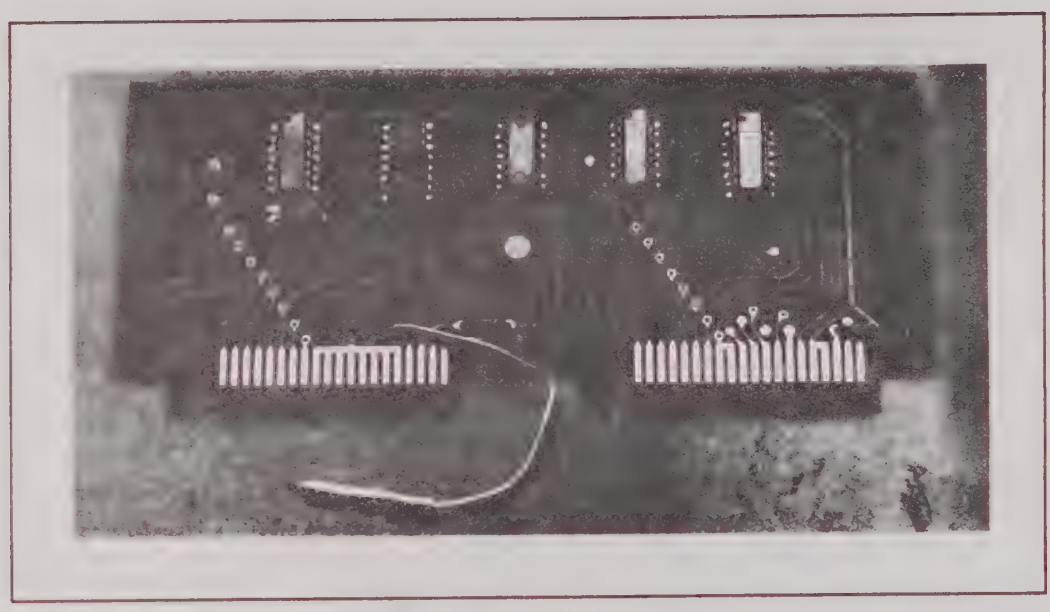

Figure 3-2. Test Card Layout

Owing to the difference in pin-outs between the 16-channel state probes and the 8-channel timing probes, this exact pattern will only be displayed on the NPC-800D when using the state B Probe.

3.2 OPERATION MODES

3.2.1 Configuration Options

To initialize all the NPC-800D functions and call the CONFIGURATION LIST, press RESET for two seconds. After the initialization cycle, the CONFIGURATION LIST is displayed and the cursor appears at the top of the list. Ten configurations are possible if the optional Counter-Timer/Signature Analyzer (CTSA) and waveform boards are installed.

3.2.2 Configuration List Display

The parameters for each of the menus associated with the CONFIGURATION LIST are described in the remainder of this section. The user is encouraged to experiment with all test parameters, triggering modes, and display formats to gain more familiarity with the range and power of the instrument, using the Logic Analyzer Test Card supplied with the NPC-800D.

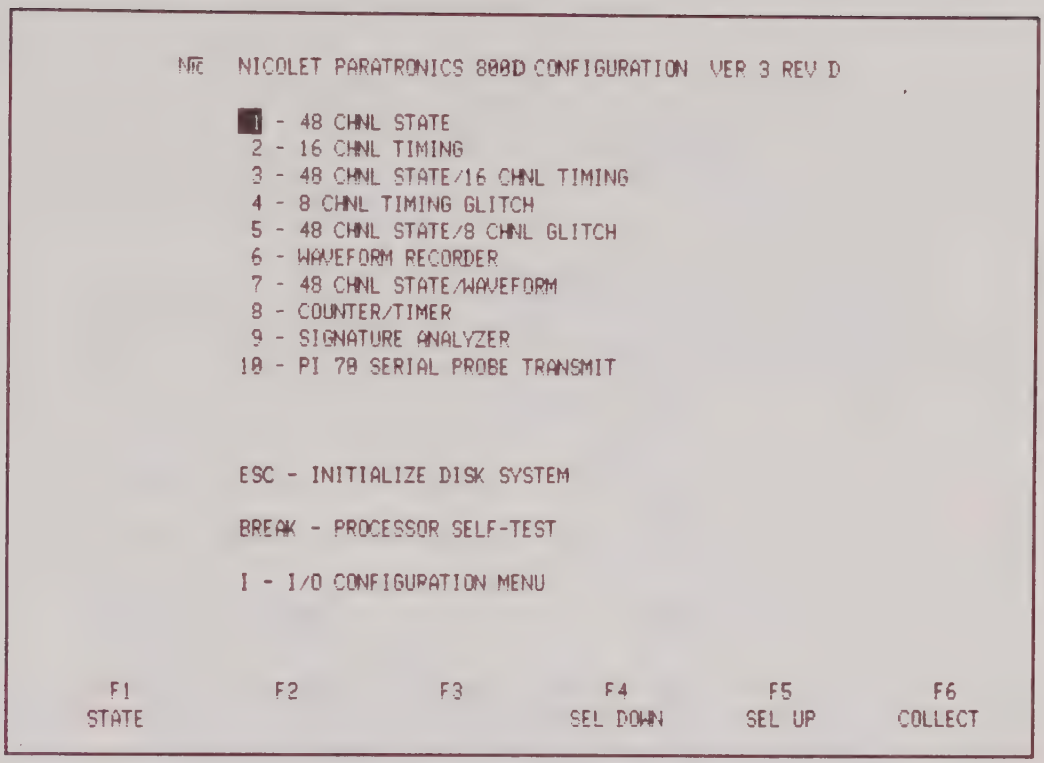
NICOLET PARATRONICS 800D CONFIGURATION VER 3 REV D
1 - 48 CHNL STATE
2 - 16 CHNL TIMING
3 - 48 CHNL STATE/16 CHNL TIMING
4 - 8 CHNL TIMING GLITCH
5 - 48 CHNL STATE/8 CHNL GLITCH
6 - WAVEFORM RECORDER
7 - 48 CHNL STATE/WAVEFORM
8 - COUNTER/TIMER
9 - SIGNATURE ANALYZER
10 - PI 70 SERIAL PROBE TRANSMIT
ESC - INITIALIZE DISK SYSTEM
BREAK - PROCESSOR SELF-TEST
I - I/O CONFIGURATION MENU
F1 STATE
F2
F3
F4 SEL DOWN
F5 SEL UP
F6 COLLECT

Figure 3-3. Configuration List

In the above display, each line represents one possible configuration of the analyzer. Position the half-intensity cursor on the number of the configuration desired, using SEL DOWN (F4) or SEL UP (F5). Then press F1 to display the menu that will be used to establish the data collection parameters.

3.3 ON-LINE HELP

The NPC-800D provides help to the user in three ways. First, when you are specifying parameters in a menu and strike an invalid key, the NPC-800D automatically prompts you with the proper keystroke selection. Second, if you are not sure what keys are valid, any time the cursor is within a field of any menu, simply press the question mark key "?" The NPC-800D provides a prompt with all valid keystrokes. Third, any time you are in a state or timing data display, pressing the function key, "LABELS", displays on the right side of the screen, a menu of all valid keystrokes.

Nicolet has provided short, concise prompts to assist you throughout your logic analysis process. Once you have gained a basic familiarity with logic analysis, the prompts should virtually eliminate the need to refer to the operator manual.

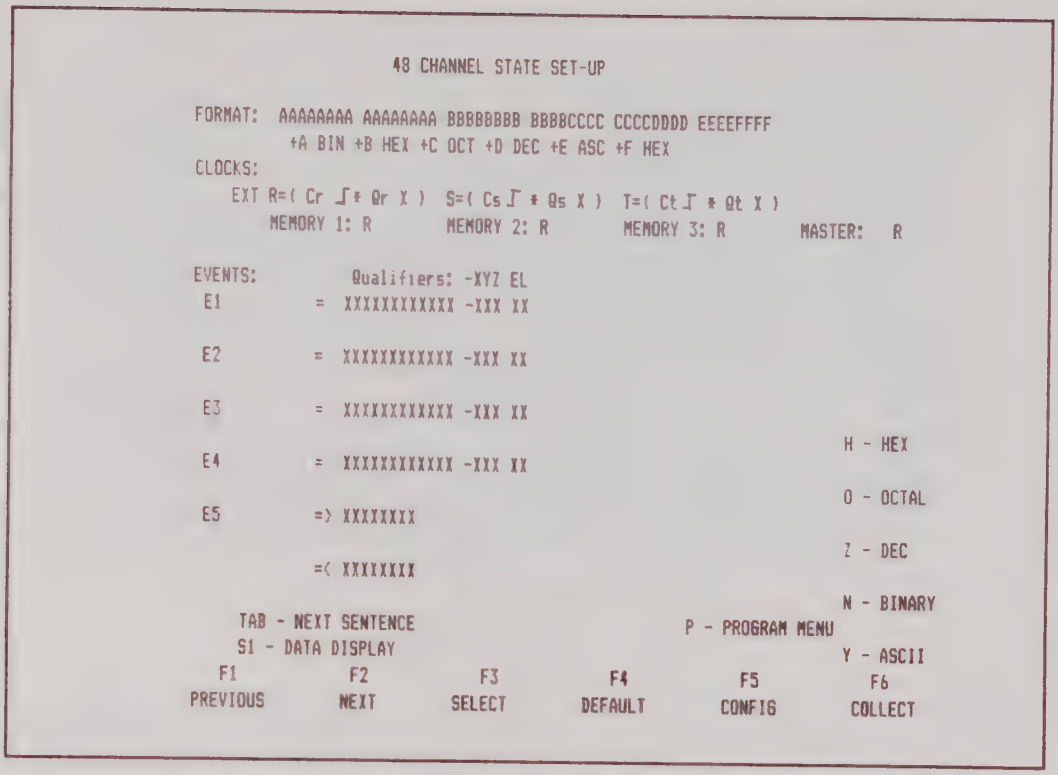
48 CHANNEL STATE SET-UP
FORMAT: AAAAAAAA AAAAAAAA BBBBBBBB BBBBCCCC CCCCDDDD EEEEFFFF
+A BIN +B HEX +C OCT +D DEC +E ASC +F HEX
CLOCKS:
EXT R=(Cr ⌊⌈ # Qr X) S=(Cs ⌊⌈ # Qs X) T=(Ct ⌊⌈ # Qt X)
MEMORY 1: R MEMORY 2: R MEMORY 3: R MASTER: R
EVENTS: Qualifiers: -XYZ EL
E1 = XXXXXXXXXXXX -XXX XX
E2 = XXXXXXXXXXXX -XXX XX
E3 = XXXXXXXXXXXX -XXX XX
E4 = XXXXXXXXXXXX -XXX XX
E5 =) XXXXXXXX
=(XXXXXXXX
H - HEX
O - OCTAL
I - DEC
N - BINARY
Y - ASCII
TAB - NEXT SENTENCE
S1 - DATA DISPLAY
P - PROGRAM MENU
F1 PREVIOUS
F2 NEXT
F3 SELECT
F4 DEFAULT
F5 CONFIG
F6 COLLECT

Figure 3-4. HELP Prompt During State Setup Menu Alteration

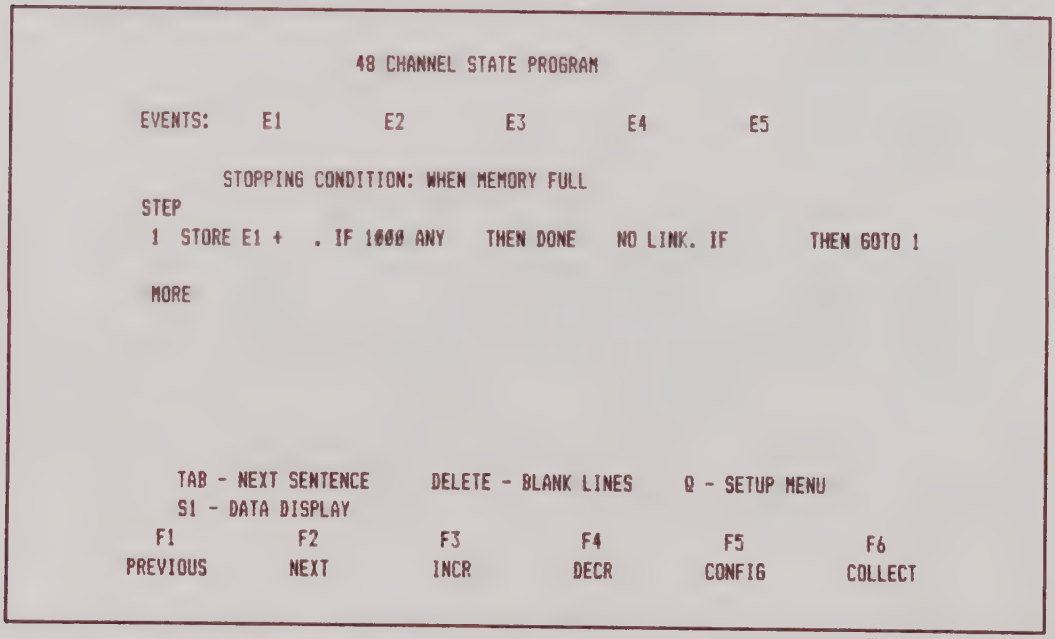

Figure 3.5 NPC-800D's 48-Channel State Program Menu (Flashing prompting messages are not shown)

3.4 STATE ANALYSIS

3.4.1 State Probe Connections

To demonstrate basic state analysis capabilities of the NPC-800D, the user need only connect the test card, select the menu, and press the COLLECT (F6) key. Captured data can then be formatted in a variety of ways.

To illustrate, connect two state probes, A and B, to the NPC-800D. The A probe connector is located toward the rear of the analyzer, leaving the C probe disconnected. Connect A probe to connector located on the left side of the test card and B probe to connector on the right side. Set switches on both probes for TRUE and TTL operation. Make sure grounded test lead on test card is not touching any circuitry. Turn power on, press COLLECT. You should see a state collection.

3.4.2 State Logic Analysis Examples

Turn NPC-800D's power switch on to produce CONFIGURATION LIST illustrated in Figure 3-3.

3.4.3 Qualifier Setup Menu

From the Configuration Menu, select 48 CHNL STATE mode and press F1 (STATE) (see Figure 3-4). This is the 48 Channel State Set up menu. From this menu you can define a user format, set up the clocks and clock qualifiers and define data and qualified events. Events can be named for later reference. From a state data display or program setup menu, you can re-enter this menu using the 'Q' key (qualifier setup).

3.4.4 Program Setup Menu

Press 'P' to enter the Program Setup menu (see Figure 3-5). From this menu you can program the steps that define your collection. The default, as shown in Figure 3-5, programs the state analyzer to collect ALL then display the data when memory is full (i.e., after 1000 samples). You can easily recall the Qualifier Setup menu by pressing 'Q' or start a collection by pressing 'F6' (COLLECT).

To summarize:

1. press CONFIG or RESET key,
2. using SEL DOWN (F4) or SEL UP (F5) key, move cursor to the 48-CHANNEL STATE mode (if necessary), and then
3. press STATE (F1) key.
4. Press 'P'.
5. Press COLLECT (F6).

Steps 3 and 4 are not required to perform the default collection.

3.4.5 State Menu

When a clock is supplied by the system under test, state menu parameters are defaulted to values which enable a data collection to be made (without changing anything). Connect the test card as discussed above and simply press COLLECT (F6) key.

3.4.6 Labels Key

To further simplify the operation of the NPC-800D, the LABELS key provides a list of valid keystrokes. After pressing LABELS key, observe (near top of list) that pressing Q returns the SETUP menu display.

Each of the keystroke options, which are listed when the LABELS key is pressed, will be discussed further on. For now, here is a description of the function of each:

Q — Calls the Qualifier SETUP menu

P — Calls the Program SETUP menu

/-DIFFERENCE — Pressing / (DIFFERENCE) key once causes the information in the main memory to be compared to the reference data in the auxiliary memory. Data words that are identical are displayed at half-intensity; words exhibiting differences are displayed at full intensity. Pressing the key again turns the feature off.

#-Compare — Pressing the # key calls the HOLD ≠ mode which is similar to COLLECT. It causes a data collection to be made according to the parameters specified in the menu. However, in the COMPARE mode, the data from the current data collection (main memory) are compared with reference data in the auxiliary memory (previously stored using the SAVE key). If equality is detected, the NPC-800D stops the data collection process and displays the data. If the data in the main memory are different than the reference data, the collection process is automatically repeated until equality is found. The message "SAMPLING" is displayed while collecting data. The message "HOLDING" is displayed when a difference between MAIN and AUX memories has been detected. Alternately, a "hold if not equal" condition can be specified in the search and compare menu.

K-SEARCH UP — Used to automatically search up through the collected data set for a specified word, range of words, or combination of words.

J-SEARCH DOWN — Similar to SEARCH UP, but the search is executed in the opposite direction.

1-DISASS — Causes the data to be displayed in mnemonics of the target microprocessor (assuming that you are using a dedicated probe and have loaded the corresponding software).

U-USER — Causes the mixed format, defined in the Qualifier Setup menu by the user, to replace the current display.

H-HEX — Causes state data or a data entry field to be displayed in a hexadecimal format.

O-OCT — Causes state data or a data entry field to be displayed in an octal format.

Z-DEC — Causes data or a data entry field to be displayed in a decimal format.

N-BIN — Causes state data or a data entry field to be displayed in a binary format.

Y-ASC — Causes state data to be displayed in 7-bit ASCII format.

^C-AUTO — Initiates data collection and displays in an auto-repeat mode. You stop this mode by pressing any key.

M-MEMSEL — M selects the AUX or MAIN memories for display.

S-SAVE* — S writes MAIN memory data into AUX memory.

R-RECALL* — R returns previous menu data into AUX memory.

NOTE

The HEX, OCT, DEC, BIN, ASC, and USER formats serve two basic functions. When used within a setup menu, the bits in each event entry field are grouped into digits corresponding to the selected format. When used with the data display, they control the format displayed.

*These commands provide temporary data storage/recall functions using the internal AUX RAM. The disk is not required for these functions.

3.4.7 48 Channel State Setup Menu

Move cursor to E1 field. Then type in the following:

E1.....0040XX...X (see Figure 3-6A).

Observe from the labels field, located at the lower right corner of the CRT, that display formats other than HEX can be selected using the indicated keys.

Now press 'P' to display the program setup menu (see Figure 3-6B). Type in two program steps:

STOP CONDITION: WHEN MEMORY FULL

STEP 1. Store E1 .IF 0001 E1 + THEN GO TO 2 NO LINK IF __ GO TO 1

STEP 2. STORE ALL .IF 0999 ANY THEN GO TO 2 NO LINK IF __ GO TO 2

(See Figure 3-6B).

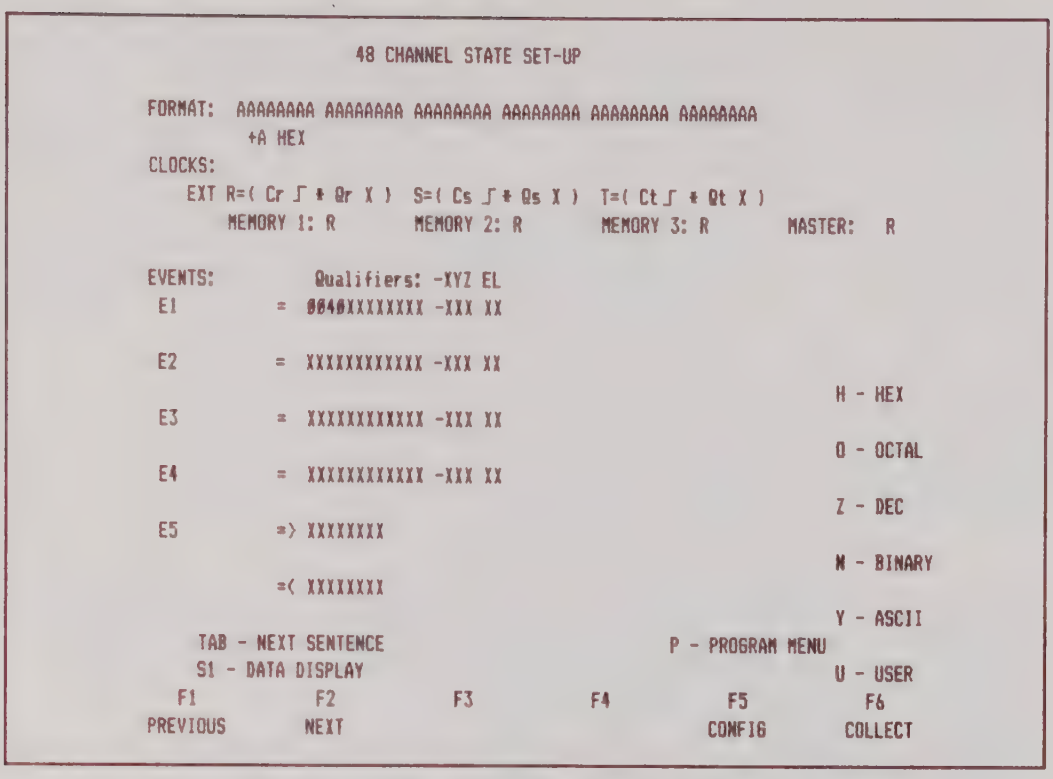
48 CHANNEL STATE SET-UP
FORMAT: AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA
+A HEX
CLOCKS:
EXT R=(Cr ⌐ ÷ Qr X) S=(Cs ⌐ ÷ Qs X) T=(Ct ⌐ ÷ Qt X)
MEMORY 1: R MEMORY 2: R MEMORY 3: R MASTER: R
EVENTS: Qualifiers: -XYZ EL
E1 = 0040XXXXXXXX -XXX XX
E2 = XXXXXXXXXXXX -XXX XX
E3 = XXXXXXXXXXXX -XXX XX
E4 = XXXXXXXXXXXX -XXX XX
E5 => XXXXXXXX
=(XXXXXXXX
H - HEX
O - OCTAL
Z - DEC
N - BINARY
Y - ASCII
U - USER
TAB - NEXT SENTENCE
S1 - DATA DISPLAY
P - PROGRAM MENU
F1 PREVIOUS
F2 NEXT
F3
F4
F5 CONFIG
F6 COLLECT

Figure 3-6A. State Qualifier Setup Menu With 0040 Selected as Event E1

Press COLLECT (F6) key to take a new data collection. With state data displayed, the word number (XX) at the top of the CRT should be (0040) for the four most significant digits (ignore rest of the word for now). See Figure 3-7 for an example.

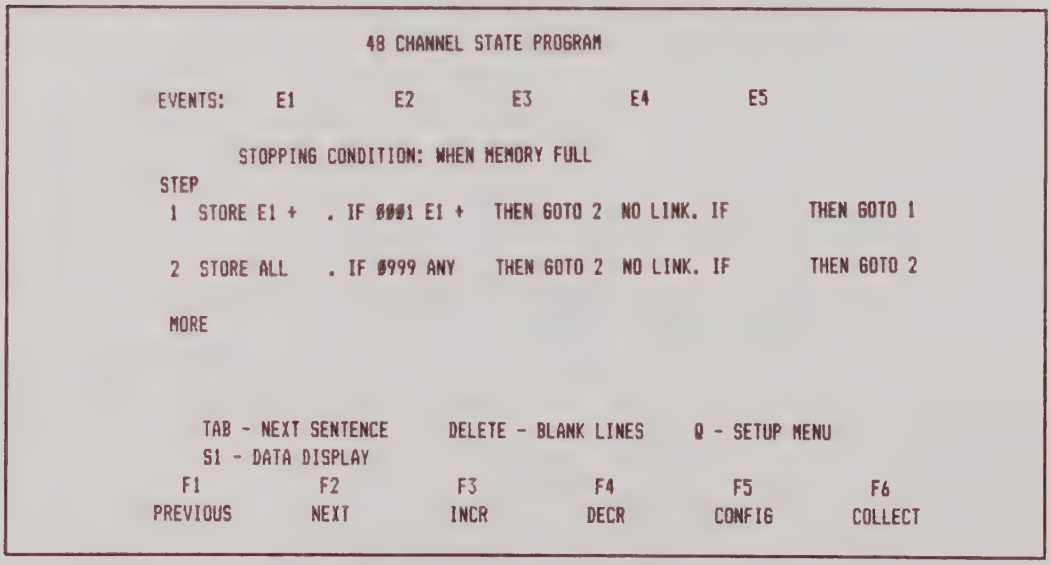
48 CHANNEL STATE PROGRAM
EVENTS: E1 E2 E3 E4 E5
STOPPING CONDITION: WHEN MEMORY FULL
STEP
1 STORE E1 + . IF 0001 E1 + THEN GOTO 2 NO LINK. IF THEN GOTO 1
2 STORE ALL . IF 0999 ANY THEN GOTO 2 NO LINK. IF THEN GOTO 2
MORE
TAB - NEXT SENTENCE
S1 - DATA DISPLAY
DELETE - BLANK LINES
Q - SETUP MENU
F1 PREVIOUS
F2 NEXT
F3 INCR
F4 DECR
F5 CONFIG
F6 COLLECT

Figure 3-6B. State Program Setup Menu Using E1

3.4.8 Display Formats

Format display in octal, decimal, binary, and ASCII by pressing, in turn, O, Z, N, and Y keys. Press H key for hexadecimal format (see Figure 3-7).

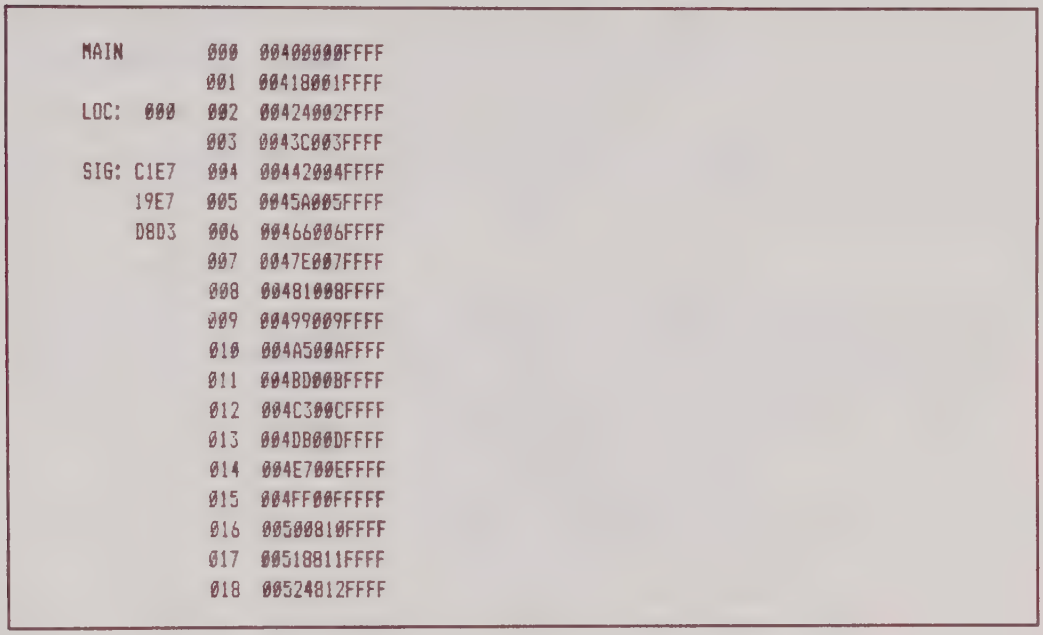

Figure 3-7. State Data Collection with 0040 as the Initial Word

3.4.9 Mixed Display Format

The NPC-800D allows the user to intermix up to five different display formats. Thus, for example, you can display the address of an I/O port in hex, characters being output in ASCII, and associated handshaking signals in binary. You can also blank out any channel by placing an X in the appropriate bit position.

Now return to the Qualifier Setup menu by pressing the Q key. Use NEXT or PREVIOUS key to move cursor to FORMAT field at top of menu, and then set display format as follows:

AAAAAAAA AAAAAAAA BBBBBBBB CCCCDDDD DDDDEEEE FFFFFFFF

A = HEX	B = ASC	C = BIN	D = HEX	E = OCT	F = DEC
(H)	(Y)	(N)	(H)	(O)	(Z)

Now press S1 to return to data display of previous collection. Data are still displayed in last format selected, HEXADECIMAL. To select new user-defined display format, press U key. To return to hexadecimal format, press H key. Pressing U key returns user format.

```
                    48 CHANNEL STATE SET-UP

FORMAT:  AAAAAAAA AAAAAAAA BBBBBBBB CCCCDDDD DDDDEEEE FFFFFFFF
          +A HEX +B ASC +C BIN +D HEX +E OCT +F DEC
CLOCKS:
   EXT R=( Cr ⌐ + Qr X )  S=( Cs ⌐ + Qs X )  T=( Ct ⌐ + Qt X )
       MEMORY 1: R        MEMORY 2: R        MEMORY 3: R        MASTER:   R

EVENTS:          Qualifiers: -XYZ EL
 E1          =  0040XXXXXXXX -XXX XX

 E2          =  XXXXXXXXXXXX -XXX XX

 E3          =  XXXXXXXXXXXX -XXX XX

 E4          =  XXXXXXXXXXXX -XXX XX

 E5          =) XXXXXXXX

             =( XXXXXXXX

    TAB - NEXT SENTENCE                          P - PROGRAM MENU
    S1 - DATA DISPLAY
  F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT       SELECT      DEFAULT     CONFIG      COLLECT
```

Figure 3-8. State Setup Menu for Mixed Format Display

3.4.10 Saving Data (S Key)

To illustrate SAVE mode, press LABELS key in top row. Perform SAVE function by pressing S key. This action causes entire data collection, test codes (SIG), and menu parameters to be stored in the NPC-800D's auxiliary RAM memory (notice flashing SAVED message). Now press M key (MEMSEL) to cause auxiliary memory to be displayed. Press M again to return main memory to screen.

3.4.11 Signatures (SIG or Test Codes)

The analyzer uses a data compression technique to generate a unique four-character "signature" for the specific data-set in each memory board. That signature is displayed in the upper-left corner of the CRT. To compare MAIN and AUX memories, compare signatures. If signatures are different, then data-sets are different.

3.4.12 COMPARE Mode (# Key)

The COMPARE mode is used to detect and isolate intermittent faults. Select the Search/Compare menu with F4 when viewing data. Move cursor to STOP IF CONDITION field, and select FALSE (save the reference data as in paragraph 3.4.10 above). Press # key (SHIFT and 3) to activate this mode. Flashing status messages indicate that analyzer is automatically collecting 1000 words and comparing main and auxiliary data.

Now short lead on test card to pad 5 located on right-hand side (B side) of test card. Flashing status message now reads HOLDING and data are displayed.

3.4.13 Memory Select (M Key)

Press M key to compare main and auxiliary test codes. Notice that one of the main memory test codes differs from corresponding auxiliary memory test code. This indicates that somewhere in the new data collection, there are one or more bits that differ between main and auxiliary memories. Now return to main memory indicated in upper-left of CRT.

3.4.14 Difference Mode (/ Key)

DIFFERENCE mode is used for rapid identification of differences between main memory and previously-saved auxiliary memory data.

Press / key (under ? key) to activate DIFFERENCE mode (this function toggles so that repeated keystrokes turn it on and off). In this mode, data words that differ between the main and auxiliary memories, are displayed at full-intensity. Data words that match are displayed at half-intensity. Press SCRL UP (F2) key to find first difference word.

3.4.15 LOCATE (F3)

For rapid location or examination of data, the LOCATE key, F3, may be used. The cursor is positioned at the LOC field. The following table illustrates the options:

Key(s) space, ddd	—Locates display with location ddd as top line, where ddd is a 3-digit number. The Model 800D differs from other versions of the 800 series in that the concept of 'trigger point' does not exist; the last 1000 qualified samples are displayed.
B	—Locates display at 000; the "beginning" of the collection.
E	—Locates display at the end of the collection; not more than 999, but may be less.
D	—Locates next "difference"; Main and Aux memory words compared.
S	—Locates the next "same"; Main and Aux memory compared.

3.4.16 Locate Difference (LOCATE D)

To illustrate: press LOCATE (F3) followed by B, then LOCATE followed by D to place first difference word at top of screen (this is another faster way to locate the first difference word).

```
MAIN          530  00524812FFFF
              531  00553C813FFFF
LOC:  530     532  00542814FFFF                    Q - SET-UP
              533  00555A815FFFF                    P - PROGRM
SIG: C3DF     534  00566816FFFF                    / - DIFFER
     D967     535  00557E817FFFF                    $ -COMPARE
     D8D3     536 *00601818FFFF                    K -SRCH UP
              537 *00699819FFFF                    J -SRCH DN
              538 *006A581AFFFF                    1 - DISASS
              539 *006BD81BFFFF                    U - USER
              540 *006C381CFFFF
DIFFERENCE    541 *006DB81DFFFF                    H - HEX
              542 *006E781EFFFF                    O - OCTAL
              543 *006FF81FFFFF                    Z - DEC
              544 *00700420FFFF                    N - BIN
              545 *00718421FFFF                    Y - ASCII
              546 *00724422FFFF                    F - FORCE
              547 *00730423FFFF                    ^C - AUTO
              548 *00742424FFFF
              549 *00755A425FFFF                   M - MEMSEL
              550 *00766426FFFF                   M - MEMSEL
              551 *00777E427FFFF                   M - MEMSEL
              552 *00781428FFFF                   M - MEMSEL
              553 *00799429FFFF                   M - MEMSEL
```

Figure 3-9. First Difference Word Occurs at 536 (Your example is probably different)

Press N key to view difference data in binary. Then press and hold M key to locate specific bits responsible for differences.

Now press LOCATE followed by S to find next group of half-intensified words that are the "same" (if any). Press SCRL DWN (F1) key once to verify (see Figure 3-10).

```
MAIN          904  00C81188FFFF
              905  00C99189FFFF
LOC:  904     906  00CA518AFFFF
              907  00CBD18BFFFF
SIG: C11F     908 *00C8318CFFFF
     19E7     909 *00C9B18DFFFF
     D8D3     910 *00CA718EFFFF
              911 *00CBF18FFFFF
              912  00D000990FFFF
              913  00D18991FFFF
              914  00D24992FFFF
DIFFERENCE    915  00D3C993FFFF
              916 *00D02994FFFF
              917 *00D1A995FFFF
              918 *00D26996FFFF
              919 *00D3E997FFFF
              920  00D81998FFFF
              921  00D99999FFFF
              922  00DA599AFFFF
              923  00DBD99BFFFF
              924 *00D8399CFFFF
              925 *00D9B99DFFFF
```

Figure 3-10. Word +904, First Word in Next Group of Data Words That are the "Same" (Your example will probably be different)

3.4.17 Locate End (LOCATE E)

Locate end of data collection by pressing LOCATE (F3) key followed by E key. Then locate word 738 by pressing LOCATE and typing in a space followed by 738. To examine remainder of the data, scroll up or down by pressing SCRL UP (F2) or SCRL DWN (F1).

NOTE

Space bar also causes data to scroll up. Backspace causes data to scroll down. Finish with 000 word at the top of CRT by pressing LOCATE and B. If you press wrong key and get an error message, use BACKSPACE and SPACE BAR key to edit the LOCATE field. Alternatively, press S1 to clear the field.

3.4.18 Search/Compare Menu (F4)

Press the COMP/SRC (F4) key. This menu permits a setup that lets you rapidly search the memories for the occurrence or nonoccurrence of programmed events. The menu is also used to define the parameters for a COMPARE equal, not-equal repeated collection (see paragraph 3.4.12).

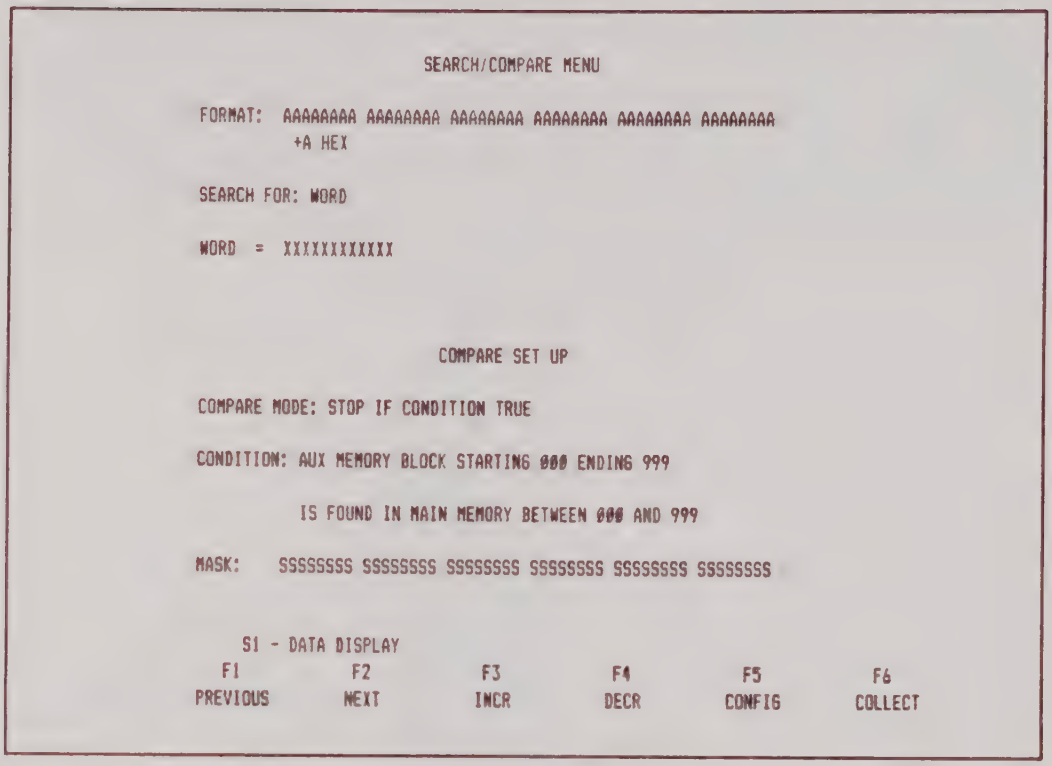

Figure 3-11. Search/Compare Menu

3.4.19 Seach For Parameter

Using NEXT (F4) and PREVIOUS (F1) locate the search for: field. Press INCR (F3) and observe: E1 _____ . Now return to the Data Display (S1). Occurrences of the E1 event may be found using the SEARCH DOWN (J) and SEARCH UP (K) keys. The parameter as previously set:

E1 = XX40 XX...X

should occur in the collection every 256 locations. When the matching data are found, they are on the top line of the data display. Additional occurrences are found by again pressing the K or J key.

3.4.20 Using the WORD Parameter

Press the COMP/SRC (F4) key again. DECR (F4) to set search for: WORD. Now use NEXT to position the cursor at the word and enter:

WORD = 004E XX...X

Press S1 to again display the data. Using SEARCHUP (K) and SEARCH DOWN (J) find the occurrences of this parameter. The event searched for may be any one of the qualified events, E1 to E5, it may be their negation (nonoccurrence) or it may be a word or range you specify, or it may be their negation.

3.4.21 Naming Events

Press S1 to display data, then Q to return to the setup menu. Position cursor to the E1 field. The reverse video field (to its right) contains an eight-character name field that allows you to symbolically name events for reference (see Figure 3-14 for an example).

3.4.22 Events As A Range

Event number 5 has two, 32-bit-wide words to define boundaries. Any events falling inside or outside of these limits can be collected. The lower limit is set equal to or greater than one 32-bit word, while the upper limit is set equal to or less than another separate 32-bit wide word (see Figure 3-16).

```
                        SEARCH/COMPARE MENU

FORMAT:  AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA
          +A HEX

SEARCH FOR: WORD

WORD  =  004EXXXXXXX


                        COMPARE SET UP
                                                          H - HEX
COMPARE MODE: STOP IF CONDITION TRUE
                                                          O - OCTAL
CONDITION: AUX MEMORY BLOCK STARTING 000 ENDING 999
                                                          I - DEC
           IS FOUND IN MAIN MEMORY BETWEEN 000 AND 999
                                                          N - BINARY
MASK:    SSSSSSSS SSSSSSSS SSSSSSSS SSSSSSSS SSSSSSSS SSSSSSSS
                                                          Y - ASCII

     S1 - DATA DISPLAY                                    U - USER
   F1          F2          F3          F4          F5          F6
PREVIOUS       NEXT                                CONFIG      COLLECT
```

Figure 3-12. SEARCH/COMPARE Menu with 009E as the Search Word

```
                    MAIN        014  004E700EFFFF
                                015  004FF00FFFFF
                    LOC:  014   016  00500810FFFF
                                017  00518811FFFF
                    SIG: C1E7   018  00524812FFFF
                         19E7   019  00053C813FFFF
                         D8D3   020  00542814FFFF
                                021  00055A815FFFF
                                022  00566816FFFF
                                023  00057E817FFFF
                                024  005B1818FFFF
                    DIFFERENCE  025  00599819FFFF
                                026  005A581AFFFF
                                027  005BD81BFFFF
                                028  005C381CFFFF
                                029  005DB81DFFFF
                                030  005E781EFFFF
                                031  005FF81FFFFF
                                032  00600420FFFF
                                033  00618421FFFF
                                034  00624422FFFF
                                035  0063C423FFFF
                                036  00642424FFFF
                                037  0065A425FFFF
```

Figure 3-13. Data Collection Showing 004E at Top of Display After Data Search is Completed

```
                        48 CHANNEL STATE SET-UP

FORMAT:  AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA
          +A HEX
CLOCKS:
    EXT R=( Cr ∫ * Qr X )  S=( Cs ∫ * Qs X )  T=( Ct ∫ * Qt X )
        MEMORY 1: R        MEMORY 2: R  .     MEMORY 3: R        MASTER:   R

EVENTS:          Qualifiers: -XYZ EL
 E1          =  0040XXXXXXXX -XXX XX

 E2          =  XXXXXXXXXXXX -XXX XX                                  H - HEX

 E3          =  XXXXXXXXXXXX -XXX XX                                  O - OCTAL

 E4          =  XXXXXXXXXXXX -XXX XX                                  Z - DEC

 E5          => XXXXXXXX                                              N - BINARY

                                                                      Y - ASCII
    TAB - NEXT SENTENCE                              P - PROGRAM MENU
    S1 - DATA DISPLAY                                                 U - USER
   F1          F2          F3          F4          F5          F6
PREVIOUS       NEXT                                CONFIG      COLLECT
```

Figure 3-14. Names for Five Events on State Setup Menu

3.4.23 Using Events

Now press P to display the program setup menu. Observe the top line listing the events; the names are displayed to help remember the setups. Using Q and P, you can also easily toggle between the two setups. Now change step 2 to read:

STORE E5 + . IF 0999 E5 + THEN GO TO 2 NO LINK IF ____ THEN GO TO 2

Event number 5 can be selected to be either a single 48-bit word recognizer, or it can be a 32-bit range of words. For example, if you want to collect any data (that is, any addresses) that are between two boundaries, enter those boundaries in E5 (see Figure 3-14). Here the range is defined to be those samples for which the A Probe has data between 0041 and 0043.

Press collect and observe the result. It takes a while to fill the memory (see Figure 3-15 for an illustration of the results).

```
MAIN          000  00400000FFFF
              001  00418001FFFF
LOC:  000     002  00424002FFFF
              003  0043C003FFFF
SIG: BE89     004  00418001FFFF
     3F89     005  00424002FFFF
     D8D3     006  0043C003FFFF
              007  00418001FFFF
              008  00424002FFFF
              009  0043C003FFFF
              010  00418001FFFF
              011  00424002FFFF
              012  0043C003FFFF
              013  00418001FFFF
              014  00424002FFFF
              015  0043C003FFFF
              016  00418001FFFF
              017  00424002FFFF
              018  0043C003FFFF
              019  00418001FFFF
              020  00424002FFFF
              021  0043C003FFFF
              022  00418001FFFF
              023  00424002FFFF
```

Figure 3-15. Data Collection, Filtered With A Range

3.4.24 Sequential Triggering

Return to the Program Menu (P). The NPC-800D incorporates eight steps of programmable triggering. One application of this feature is in the tracing of nested subroutines.

Set up state menus as shown in Figure 3-16. Use P key to access PROGRAM menu at STEP 1. Press NEXT (or TAB KEY for fewer keystrokes) to access the MORE field; then press SELECT key to activate the next STEP). Events should remain as previously described in paragraph 3.4.23.

```
                        48 CHANNEL STATE PROGRAM

EVENTS:     E1          E2          E3          E4          E5

        STOPPING CONDITION: WHEN SEQUENCE DONE
STEP
 1  STORE E1 +    . IF 0001 E1 +    THEN GOTO 2  NO LINK. IF        THEN GOTO 1

 2  STORE ALL     . IF 0001 E2 +E4  THEN GOTO 3  NO LINK. IF        THEN GOTO 2

 3  STORE NONE    . IF 0001 E3 +    THEN GOTO 4  NO LINK. IF E1 +   THEN GOTO 1

 4  STORE E5 +    . IF 0001 E2 +    THEN GOTO 5  NO LINK. IF        THEN GOTO 4

 5  STORE ALL     . IF 0001 E2 +E4  THEN GOTO 6  NO LINK. IF        THEN GOTO 5

 6  STORE E1 +E5  . IF 0020 E5 +    THEN GOTO 7  NO LINK. IF        THEN GOTO 6

 7  STORE NONE    . IF 0001 ANY     THEN GOTO 1  NO LINK. IF        THEN GOTO 7

 8  STORE ALL     . IF 0001 ANY     THEN DONE    NO LINK. IF        THEN GOTO 8
    TAB - NEXT SENTENCE      DELETE - BLANK LINES     Q - SETUP MENU
    S1 - DATA DISPLAY                              RETURN-DISK SYS
  F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT        INCR        DECR        CONFIG      COLLECT
```

Figure 3-16. State Program Menu

3.4.25 Collection Status

Press COLLECT. Status messages on bottom of display show how the NPC-800D is progressing through the program sequence. As set up, this program will never finish; the status message shows the program steps from 1 to 6, back to 1, repeatedly.

```
MAIN          000  00466006FFFF
              001  00400000FFFF
LOC:  000     002  00418001FFFF
              003  00424002FFFF
SIG: C3B7     004  0043C003FFFF
     BFB7     005  00400000FFFF
     D8D3     006  00418001FFFF
              007  00424002FFFF
              008  0043C003FFFF
              009  00400000FFFF
              010  00418001FFFF
              011  00424002FFFF
              012  0043C003FFFF
              013  00400000FFFF
              014  00418001FFFF
              015  00424002FFFF
              016  0043C003FFFF
              017  00400000FFFF
              018  00418001FFFF
              019  00424002FFFF
              020  0043C003FFFF
```

Figure 3-17. Data Collection Corresponding to Example

3.4.26 Force Display (F)

If there are not enough incoming data to fill the 1000-word state memory, press F key and the amount of data words actually collected can be displayed.

If the trigger steps that are programmed do not allow completion of the collection, go to step 8; the collection task will continue indefinitely. The F key forces completion. Press F and observe the result (see Figure 3-17). Press F3 (Locate) and then B (Beginning).

If no input clock is being detected or if the clock period is greater than approximately one second, the message WARNING—SLOW CLOCK 0000 will be displayed.

3.4.27 Non-occurrence Triggering

Before discussing these tasks, observe the third and fourth lines from the bottom of the setup menu (see Figure 3-16). Place cursor at step 2 and press the DELETE (DEL) key. Step 1 is the only program step remaining. Now SELECT (F3), step 2, and reprogram the sequence as follows:

STOPPING CONDITION: WHEN SEQUENCE DONE

Step 1: STORE E1. IF 0001 E1 THEN GO TO 2
Step 2: STORE E2. IF 0001 E2 THEN GO TO 3 NO LINK IF E2 THEN GO TO 1
Step 3: STORE ALL. IF 0100 ANY THEN DONE

Press Q and redefine E1 as 0044XX....XX. Now collect (F6). If the test pattern outputs correctly, 0045 (E2) always follows 0044 (E1); consequently it should never be done. If you now short the A channel bit 0 to ground, the collection completes. Use the search to locate the first occurrence of E1; the collection should have a lot of 0044 followed by the other bad data. To establish the search, call up the search word in the search/compare menu; then press J to search down while viewing the data display.

3.4.28 External Trigger Qualifiers

Press Q to display the setup menu. The 5-bit external qualifier field corresponds to the header:XYZ EL.The XYZ bits correspond to external qualifier lines (Q2) coming in through pin 20 (in each of the three probes). The E bit corresponds to any additional external qualifier line coming in through the EXTERNAL INPUT BNC connector at the rear of the analyzer. The L bit corresponds to the LINK BNC connector at the rear of the analyzer or to the internal linkage from the timing analyzer or waveform recorder.

3.4.29 External Event Qualifiers

Each EVENT word can also be set up to require the occurrence of qualifier events: XYZ EL. They act as enabling signals to incoming datawords. Thus, if Event 1 were set up as follows:

0040 XX XXXX XX-1XX 1X,

Then a probe qualifier on pin 20 must be high (1) and external BNC input on the rear panel must also be high (1) when 0040 occurs; otherwise, the analyzer will not recognize the occurrence of this event.

Try setting the qualifier and then COLLECT (F6). You should get a warning slow clock message; then force the collection and restore the qualifiers to 'X'.

L bit is another even T qualifier that links any program menu step from the successful triggering of timing or waveform analyzers or another analyzer connected to LINK BNC on back panel (use of L bit is discussed in more detail later).

In microprocessor applications, for example, event qualifiers can control triggering by using signals that are generally not on the address bus or data bus, or are not required in data collection. As such, they can be considered as extra channels that are not displayed. Thus, for the NPC-800D, a 53-bit-wide word can be specified (48 data channels plus 5 trigger qualifiers).

3.4.30 Clock Setup

To position the cursor at the CLOCKS field, press Q and PREVIOUS (F1) key several times. So far all of the collections have been made by the test card using the external clock input to the A Probe. In the definition shown (see Figure 3-18), all memories use the R clock. It is unqualified. Clock is on the rising edge and is sourced by Cr (the clock from the A Probe). Finally, an internal clock is selected. Press the SELECT (F3) key. The clock source will change to an INTERNAL clock at the frequency shown. Asynchronous collections can be made using the Model 800D state analyzer. Set the INT clock to 50μs and press COLLECT (F6) key. Each pattern word should occur approximately five times.

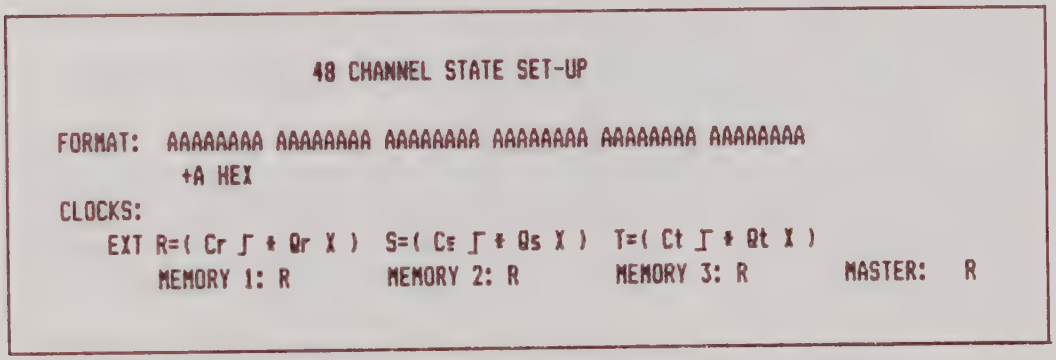
48 CHANNEL STATE SET-UP
FORMAT: AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA
+A HEX
CLOCKS:
EXT R=(Cr ⌐ + Qr X) S=(Cr ⌐ + Qs X) T=(Ct ⌐ + Qt X)
MEMORY 1: R MEMORY 2: R MEMORY 3: R MASTER: R

Figure 3-18. Clock Setup Menu Fields

3.4.31 Using Clocks To Demultiplex

Press Q once more and position the cursor again at the CLOCKS field. Select EXT Clock mode. Set up the field as follows:

R=(Cr ⌡* Qr 0) S=(Cs ⌡* Qs 1)

MEMORY 1: R
MEMORY 2: S
MASTER: R

Press COLLECT (F6) key. The date collected by the A probe should show only even numbers while the data collected by the B probe should show only odd numbers; this is true because the test card connects the qualifiers, Qr and Qs, to the least significant bit of data. In the example, we have real demultiplexed information. The example illustrates the power of the clock and clock qualification scheme (see Figure 3-19). The Model 800D has three memories and three probes. These can be clocked independently or collectively by using any of the clocks and their associated qualifiers. The A probe qualifier can also be selected as positive or negative edge, or a level or disabled (X).

```
MAIN            000   0002 83C1
                001   0004 C3C3
LOC:   000      002   0006 A3C1
                003   0008 E3C3
SIG:  C410      004   000A 93C1
      C405      005   000C D3C3
      D6D1      006   000E B3C1
                007   0010 F3C3
                008   0012 8BD1
                009   0014 CBD3
                010   0016 ABD1
                011   0018 EBD3
                012   001A 9BD1
                013   001C DBD3
                014   001E BBD1
                015   0020 FBD3
                016   0022 87E1
                017   0024 C7E3
                018   0026 A7E1
                019   0028 E7E3
                020   002A 97E1
                021   002C D7E3
                022   002E B7E1
```

Figure 3-19. Demultiplexed Collection

3.4.32 Qualified Clock Relationship

Each probe has an independent clock, clock qualifier and event qualifier. Each memory can be clocked independently or collectively. One clock is selected as MASTER. This clock advances data through the pipeline into the event recognizers and then into memory. In the setup, if we change Qs to don't care (X) and the MASTER to S, then the A collection will latch the B probe data every cycle and the A probe data every other cycle. The result is that each A probe sample appears twice in memory (see Figure 3-20). The MASTER clock should normally have the longest period and occurs last relative to the intermediate clocks. In the example, this was not the situation as the figure illustrates.

The first intermediate clock should not occur earlier than 10 nanoseconds after the master. The last intermediate clock could serve as a master clock also. In the example, R and S are synchronous with R at twice the period of S.

```
MAIN            000   0000 83C1
                001   0002 43C2
LOC:  000       002   0002 C3C3
                003   0004 23C0
SIG:  BAF0      004   0004 A3C1
      43D4      005   0006 63C2
      D6D1      006   0006 E3C3
                007   0008 13C0
                008   0008 93C1
                009   000A 53C2
                010   000A D3C3
                011   000C 33C0
                012   000C B3C1
                013   000E 73C2
                014   000E F3C3
                015   0010 0BD0
                016   0010 8BD1
                017   0012 4BD2
                018   0012 CBD3
                019   0014 2BD0
                020   0014 ABD1
                021   0016 6BD2
                022   0016 EBD3
```

Figure 3-20. Collection, Master Clock Period 2X Intermediate

3.4.33 Autocollect

Press CTRL and C simultaneously to activate an automatically repeating data collection mode. Press any ASCII key to stop.

AUTOCOLLECT mode is useful to view a small portion of data collected while making changes to circuit under test. An example is varying the power supply voltage.

3.5 TIMING ANALYSIS

3.5.1 Timing Analysis Examples

The timing analyzer is separate from the state analyzer that has just been reviewed. It records data in a separate memory and uses its own menu for setup. The following sections review its functions and how they are used.

3.5.2 Setup

Before starting this test, connect the two A and B Model 81A timing probes to the NPC-800D. Then connect these probes to the test card's A and B outputs, respectively (leave state probes plugged into NPC-800D).

3.5.3 Initialize

Unless you have just turned on the power to begin this section, before continuing, press RESET key for two seconds to reinitialize analyzer.

3.5.4 16-Channel Timing Menu / 1000 Words, 200 MHz Max.

1. To Call Menu

   a. Press CONFIG or RESET key.
   b. Press soft-key labeled SEL DOWN or SEL UP as appropriate to move cursor to 16-CHANNEL TIMING position.
   c. Press F1 to select TIMING menu.
   d. Place cursor in CLOCK field, at top of menu.

```
                    16 CHNL TIMING/STATE  MENU

              100nS CLOCK
 TRIGGER WHEN:
               TRIG OCCURS >= 0000 CLOCKS AFTER FIRST ARM
              CHNL NO. A76543210 B76543210  EDGEQ  FILTER  LINKAGE
ARM (0,1,X):           XXXXXXXX  XXXXXXXX    X      OFF     NONE
TRIG (0,1,X):          XXXXXXXX  XXXXXXXX           OFF     NONE
PRE-TRIGGER:   00%

                       AAAAAAAA  BBBBBBBB
DISPLAY ORDER (0-7,X): 76543210  76543210
DISPLAY POLARITY (+,-): ++++++++  ++++++++
                              A PROBE             B PROBE
      THRESHOLD:       CH 0-3  CH 4-7  CLK, Q   CH 0-3  CH 4-7
  (-6.4V TO +6.35V)     +1.60   +1.60   +1.60     +1.60   +1.60
  INPUT MODE (S,L):     SAMPL   SAMPL            SAMPL   SAMPL




   S1 - STATE DISPLAY
   S2 - TIMING DISPLAY
 F1          F2          F3          F4          F5          F6
PREVIOUS     NEXT                                CONFIG      COLLECT
```

Figure 3-21. 16-Channel Timing Menu

2. Explanation of Clock Select Menu

   The CLOCK SELECT field displays the sampling interval (internal clock) or clock polarity and qualifier (external clock). Clock speed is selected using SLOWER (F3) and FASTER (F4) keys. External clock polarity is selected by P, for positive edge, or N, for negative edge. If an external clock is selected, CLOCK QUALIFIER field is displayed, allowing selection of 1, 0, or X for the external clock qualifier bit.

3.5.5 Collection

Leave all menu parameters set at their default values (see Figure 3-21). Press COLLECT (F6) key. Notice a brief status message TRIGGERED that appears in lower left corner of CRT screen. When a timing data collection is complete, the message "DONE" is displayed briefly in its place, and the screen fills with timing diagram display.

3.5.6 Clock Speed

Data display shows sampling rate (clocking speed) in top left-hand corner. Default value of 100 nanoseconds is very fast for the test card's CMOS circuit; consequently little activity is seen on timing diagram. To return to menu and enter clock field press C. Use F3 key (slower) to set sampling rate to 100 microseconds. Press F6 (COLLECT) to collect data. Resulting collection is shown in Figure 3-22. Notice high and low transitions shown on most lines and cross hatching on lines A1 and A2 (this will be discussed later in paragraph 3.5.10).

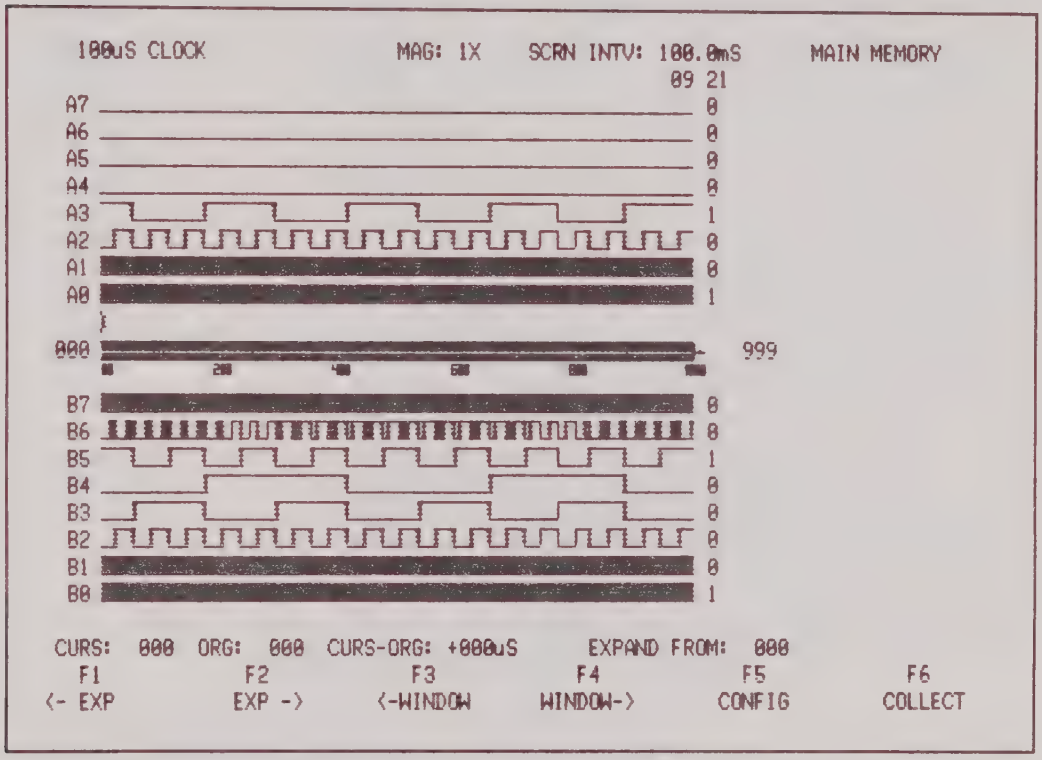

Figure 3-22. Typical Timing Diagram Display

3.5.7 Timing Diagrams

The NPC-800D displays all 16 channels of timing data simultaneously, but in two groups of 8. The cursor is used to measure time between events. The value of corresponding data in binary at current cursor location is displayed at right end of each timing trace. The NPC-800Dprovides a unique "shaded" display for those timing diagrams whose transitions are occurring too close together to be resolved at lower screen magnifications. This feature reduces the possibility of making erroneous visual time measurements. Shaded areas are always resolved into discrete lines at X10 or X20 magnification factors.

3.5.8 User Prompts

During this session we frequently move back into various menu fields from the data display. To make this easier and faster, as in the state analyzer, pressing LABELS key displays a menu of valid keystrokes. While in the menu, if invalid key or the ? key is pressed, the analyzer prompts you with a selection of proper keystrokes.

3.5.9 Labels

Prompting messages can be accessed (after a data collection is displayed) by pressing LABELS key. It identifies all direct entry functions (see Figure 3-23).

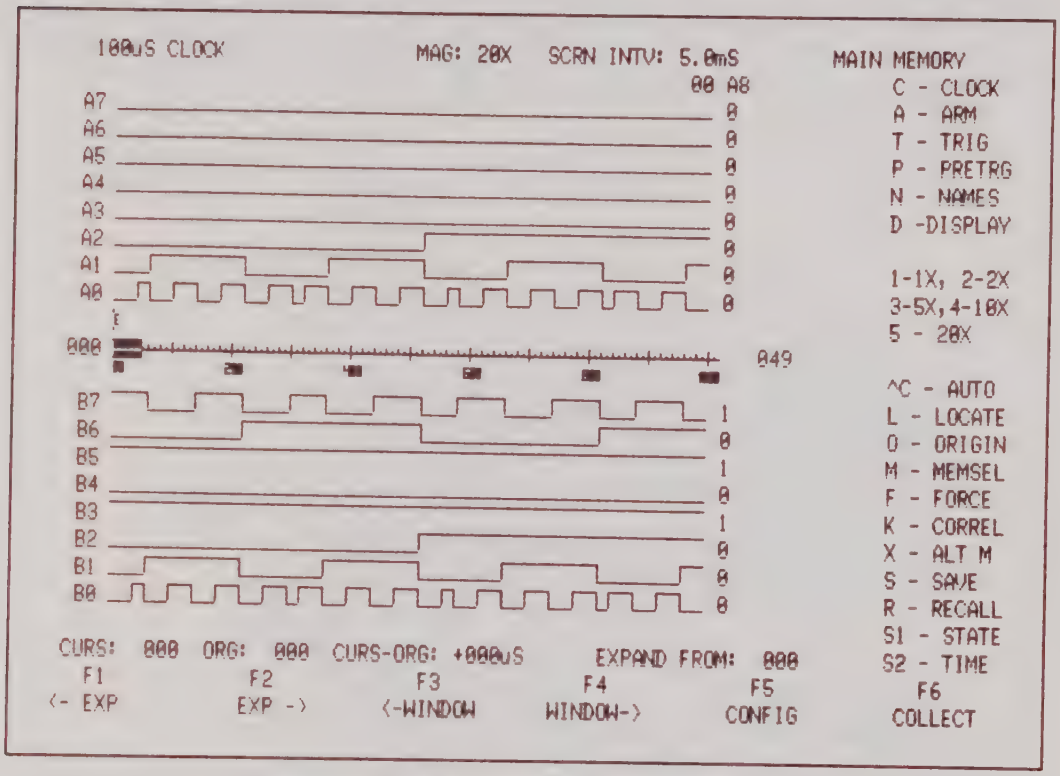

Figure 3-23. LABELS Function on Timing Diagram

C-CLOCK
A-ARM
T-TRIG
P-PRETRIG
D-DISPLAY

With cursor located in particular field selected by each key, these keys call the TIMING setup menu. For example, T places cursor in menu's TRIGGER field. Other fields can then be accessed by using PREVIOUS or NEXT. Also, S2 can be pressed again to call data.

N-NAMES

N key places a cursor at right of timing diagram display for generation of an 8-character alphanumeric label for each channel. These labels are defined by the user to identify and document displayed signals. Pressing ESC key terminates NAME mode.

1-1X
2-2X
3-5X
4-10X
5-20X

Numeric keys 1, 2, 3, 4, and 5 expand timing (and waveform) displays by indicated factor. Expansion occurs from right of current position of expansion cursor, represented on screen by symbol E. When expansion occurs, expansion cursor, normally is positioned to the left of screen. Exact position of expansion cursor is indicated on screen in EXPAND FROM field.

L-LOCATE (CURSOR) — L is used to bring timing cursor rapidly onto left-hand edge of screen. This is useful when cursor's present location is away from present window of data being viewed.

O-ORIGIN — O is used to simplify time measurements with the cursor. Pressing this key causes current position of cursor to become the ORIGIN. In waveform mode, voltage at current cursor position also becomes ORIGIN value. Moving cursor from this position then causes differences in time (and voltage) between cursor and origin values to be displayed.

C - AUTO — Control-C causes analyzer to collect and display data continuously.

M-MEMSEL — M, MEMSEL, selects MAIN or AUXILIARY memory for display.

F-FORCE — If COLLECT key has been pressed, but triggering conditions have not been met (or if collection is only partially complete), F, the FORCE DISPLAY key, stops data collection process and causes captured data to be displayed. Last data word collected is automatically defined as trigger point. Pressing FORCE DISPLAY key allows prior 999 words to be viewed, regardless of pretrigger field setting.

K-CORREL — K is used to calculate correlation (figure of merit) between current data collection in main memory and reference data in auxiliary memory. Computation is performed independently for each active channel. Total bit-for-bit correspondence results in a correlation of 1.000 being displayed. A one-bit difference, for example, reduces correlation to 0.999 (for a correlation example, see paragraph 3.5.31).

NOTE

When K key is pressed, correlation values replace timing diagram names. Press S2 to return the names.

X-ALT M — X key causes display to alternate automatically between MAIN and AUX.

S-SAVE — After a data collection has been made, pressing S key saves main memory contents into auxiliary memory. Included with saved data is the set of menu parameters and test codes used to obtain data collection.

R-RECALL* — Pressing R key recalls menu information and data stored in auxiliary memory using SAVE key. This function allows a previous test to be repeated without having to re-enter parameters.

**Pressing RECALL key causes current menu parameters to be lost.*

S1-STATE	S1 key allows user to select state equivalent of timing diagram or analog waveform displays. Pressing S1 again calls timing display.
S2-TIME	S2 key returns timing display.

3.5.10 Magnification

Using the 2 to 5 numeric keys indicated in the DISPLAY MENU, try magnification factors between 2X to 20X. After each higher magnification key is pressed, the inverse video indicator at the center of the screen reduces proportionately in size. This indicator shows location and amount of timing data currently being displayed relative to entire 1000-word data collection. At 20X magnification, notice that inverse video indicator is only five percent of its original (1X) size and that the screen is now displaying timing data between memory locations 000 and 049 (see Figure 3-23).

3.5.11 Trigger Location

Horizontal inverse video graticule at middle of display represents entire 1000 samples in memory. Notice that small 00 indicator at left end of graticule is intensified. This indicates 00 percent pretrigger value set in previously. With 00 percent pretrigger, the first word in data collection always is the trigger word.

Numbers at left and right-hand sides of graticule indicate boundary values of displayed data.

3.5.12 ⟨-WINDOW, WINDOW-⟩ (F3, F4)

The ⟨-WINDOW and WINDOW-⟩ keys are used to select a specific portion of the data collection currently being displayed. This window, and its position in data memory, are shown by the inverse video portion of the graticule below the waveforms on the screen.

NOTE

For any expansion factor other than X1, all data memory cannot be displayed at one time.

For these larger expansion factors, pressing either WINDOW key steps or sweeps (using REPEAT) window so that entire data collection can be viewed. Moving window to right, for example, causes displayed data to move from right to left.

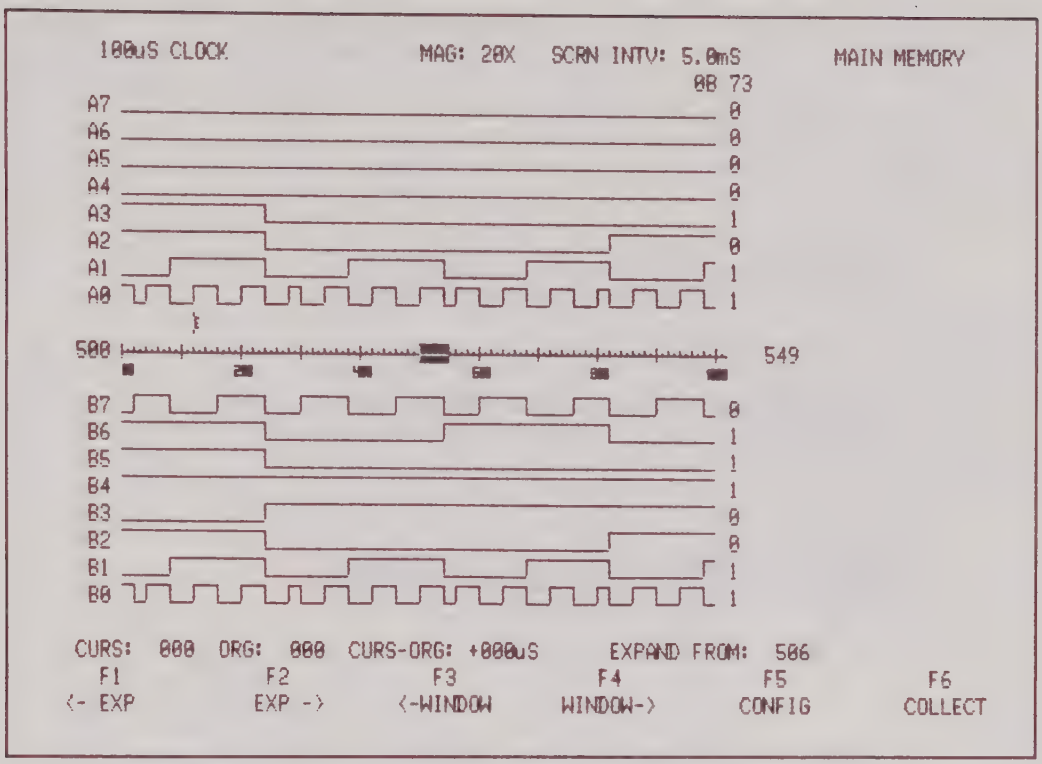

Figure 3-24. Magnified Data Display X20 (Locations 500 to 549)

3.5.13 Expand (E)

Press X2 to obtain timing data. Notice expansion cursor E, which is positioned just above center graticule, used to define the position from which display will be expanded. Press F2 to sweep symbol toward center of display at location 500 (see Figure 3-25). Use F1 to step back if you overshoot. Press Magnification keys 1-5 to expand picture as required.

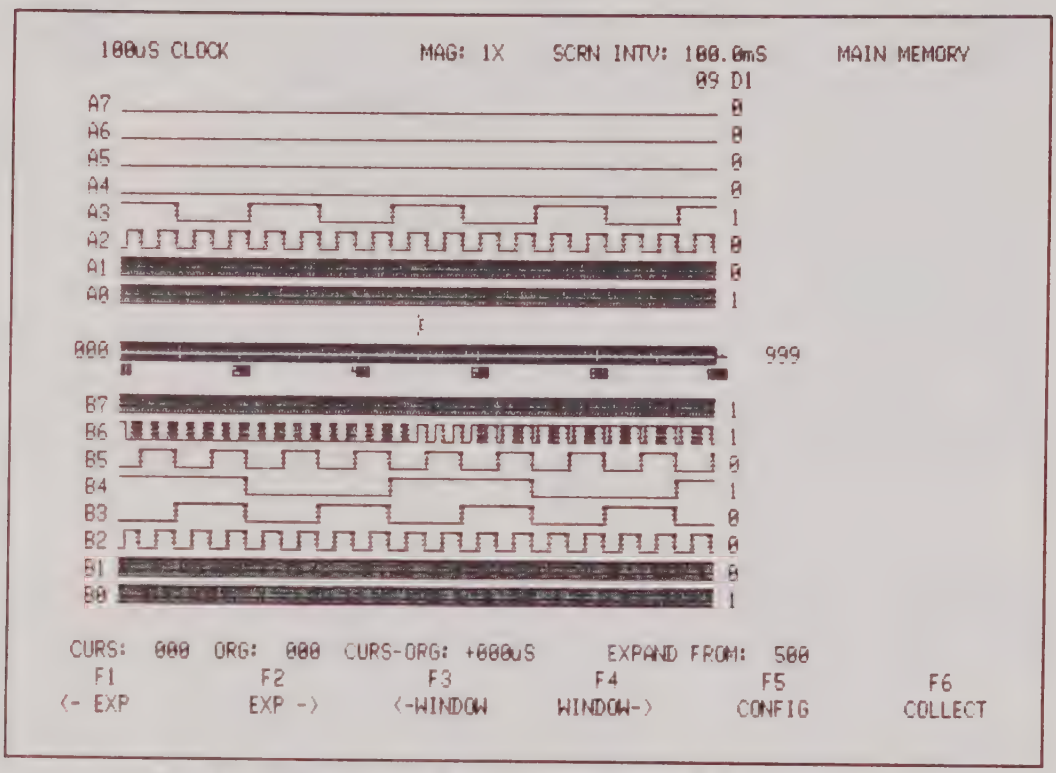

Figure 3-25. Timing Display with Expansion Symbol, E, At Location 500

3.5.14 Expansion Indicator (E)

By pressing EXPAND keys ⟨-EXP or EXP-⟩, this indicator can be moved anywhere within the screen. By pressing EXPAND keys ⟨-EXP or EXP-⟩. It is used to locate an area in the current screen that requires additional magnification. Expansion is always to right of indicator.

3.5.15 ⟨-EXP, EXP-⟩ (F1, F2)

The ⟨-EXP and EXP-⟩ keys move expansion cursor, E, back and forth on the screen. The expansion cursor cannot be moved off the screen.

3.5.16 Cursor

To set cursor quickly (currently at 000) to left side of screen, simply press the L (LOCATE CURSOR) key as indicated in LABELS menu. Bring cursor to approximate center of CRT by pressing SPACE BAR key (Overshooting can be remedied by pressing BACKSPACE key)

3.5.17 Cursor Right, Cursor Left

SPACE BAR and BACK SPACE keys step timing cursor right or left, respectively, through data collection.

As cursor moves, its current position is indicated at screen's lower left. Cursor measures time between events in data collection and can be used in conjunction with the ORIGIN function. Even if cursor is off-screen, its position is still indicated correctly. Also, the binary value corresponding to the state of each input line at the cursor appears at right-hand-side of screen. Whether they are displayed or not, associated hexadecimal value corresponds to all channels in memory. Binary and hexadecimal values change when display order is modified in the menu

3.5.18 Time Measurements Using Cursor and Origin (O)

In this step, you measure the relative time between edges in two channels. Visually select an edge (rising or falling) in channel B2 and another edge (later in time) in channel B6. Step cursor so that it aligns with selected edge in channel B2. Notice value of cursor position indicator at lower left of screen. Now press letter O to reset origin from 000 to current cursor location. The CURS-ORG indicator should now read zero units of time (When external clock is used, indicator reads +0CS, where CS stands for clock samples). Next, step cursor to selected edge on channel B6. CURS-ORG indicator now directly reads time between these two edges (Figure 3-26 shows one example of using this measurement procedure).

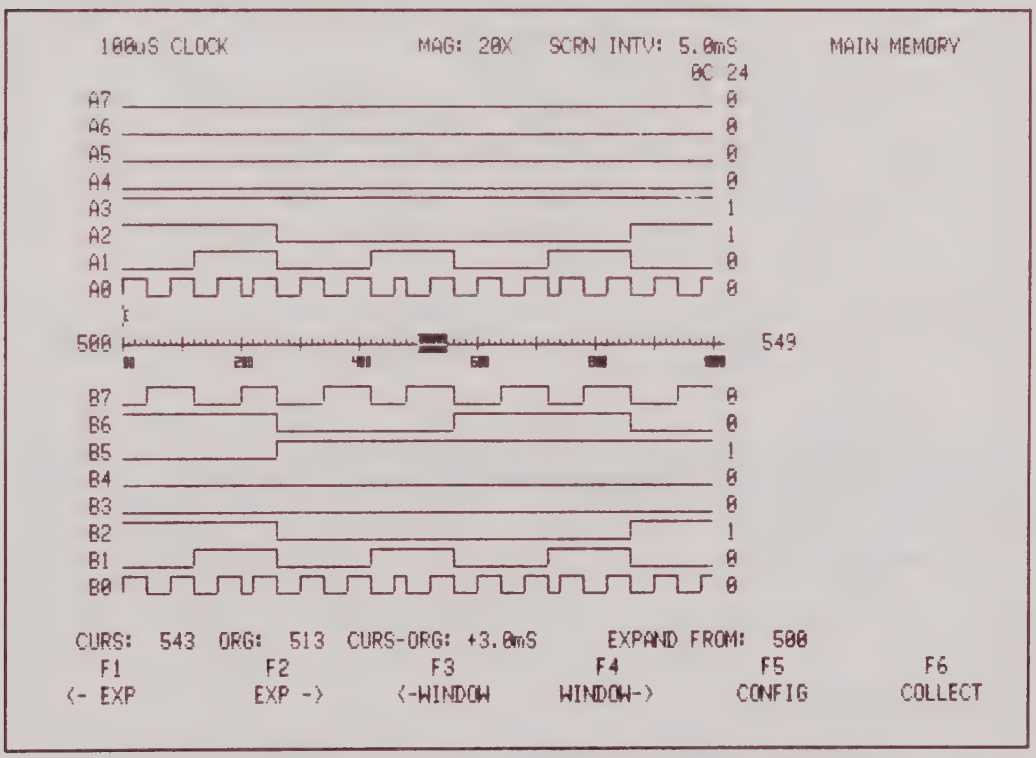

Figure 3-26. Measuring Relationship Between Timing Data Edges

3.5.19 Timing Display Manipulation

The NPC-800 allows you to change both the order in which timing diagrams are displayed and their polarity.

3.5.20 Display Order (0-7, X)

Access DISPLAY ORDER field by pressing D key. Labels A and B correspond to 8-bit data groups coming through A and B probes. X blanks out a line, and numbers 0-7, entered in any order (or even repeated), set up display order within probe group. To illustrate timing display flexibility of NPC-800, set in following display order for eight most significant channels: B4 - A0 - A6 - B7 - B0 - X -B4 - A2. Use NEXT key to step down to DISPLAY POLARITY field. Then set in following display polarity: − + + + − + + + (see Figure 3-27).

```
                    16 CHNL TIMING/STATE  MENU

              100uS CLOCK
 TRIGGER WHEN:
               TRIG OCCURS >= 0000 CLOCKS AFTER FIRST ARM
              CHNL NO. A76543210 B76543210  EDGE@  FILTER  LINKAGE
ARM (0,1,X):           XXXXXXXX  XXXXXXXX    X      OFF     NONE
TRIG (0,1,X):          XXXXXXXX  XXXXXXXX           OFF     NONE
PRE-TRIGGER:  00%

                       BAABBXBA  BBBBBBBB
DISPLAY ORDER (0-7,X):  40670X42  76543210
DISPLAY POLARITY (+,-): -+++-+++  ++++++++
                              A PROBE              B PROBE
      THRESHOLD:        CH 0-3  CH 4-7  CLK, @    CH 0-3  CH 4-7
  (-6.4V TO +6.35V)      +1.60   +1.60   +1.60      +1.60   +1.60
  INPUT MODE (S,L):      SAMPL   SAMPL               SAMPL   SAMPL




   S1 - STATE DISPLAY
   S2 - TIMING DISPLAY
 F1          F2          F3          F4          F5          F6
PREVIOUS     NEXT                                CONFIG      COLLECT
```

Figure 3-27. Menu showing NPC-800D's Timing Display Flexibility.

3.5.21 Display Polarity (+, −)

Use of + or − keys here displays respectively, a TRUE or COMPLEMENTED timing diagram.

3.5.22 S2 4 (10X)

Now press S2 and 4 (for 10X) keys. At 10X magnification, the timing diagram is similar to Figure 3-28. The NPC-800 permits the display of any mix of inverted and noninverted channels. Any channel can be blanked out and repeated. In Figure 3-28, B4 is inverted at top of CRT and is adjacent to A0. Near center of display, B4 appears noninverted and is adjacent to A2.

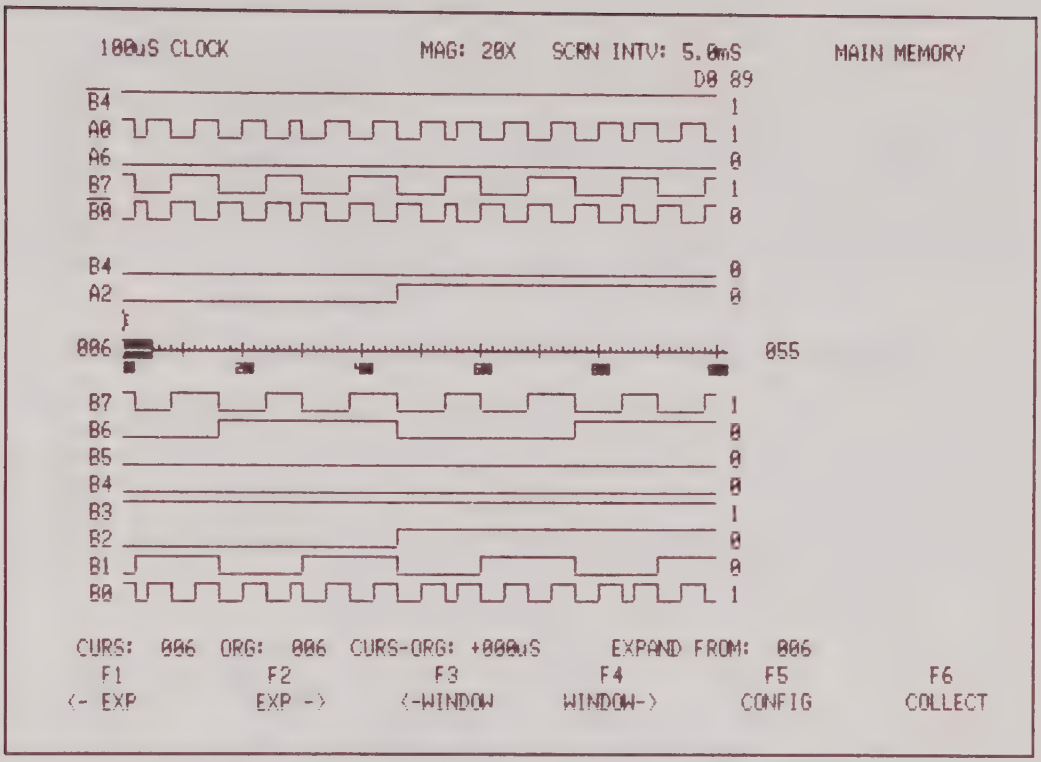

Figure 3-28. Flexibility of NPC-800D's Timing Diagram Display

Press RESET key to initialize all parameters for next steps. Then select 16-channel timing mode and press COLLECT. Set CLOCK to one millisecond and COLLECT again.

3.5.23 Names

Press N key to activate NAME cursor at upper right-hand side of screen. Each channel can have up to eight characters for a name. Enter characters from ASCII keyboard, terminate each line with a CR, and when all required labels have been assigned: press ESC key. To edit labels, use SPACE BAR. To move cursor and type in new entries use BACKSPACE as required (see Figure 3-29).

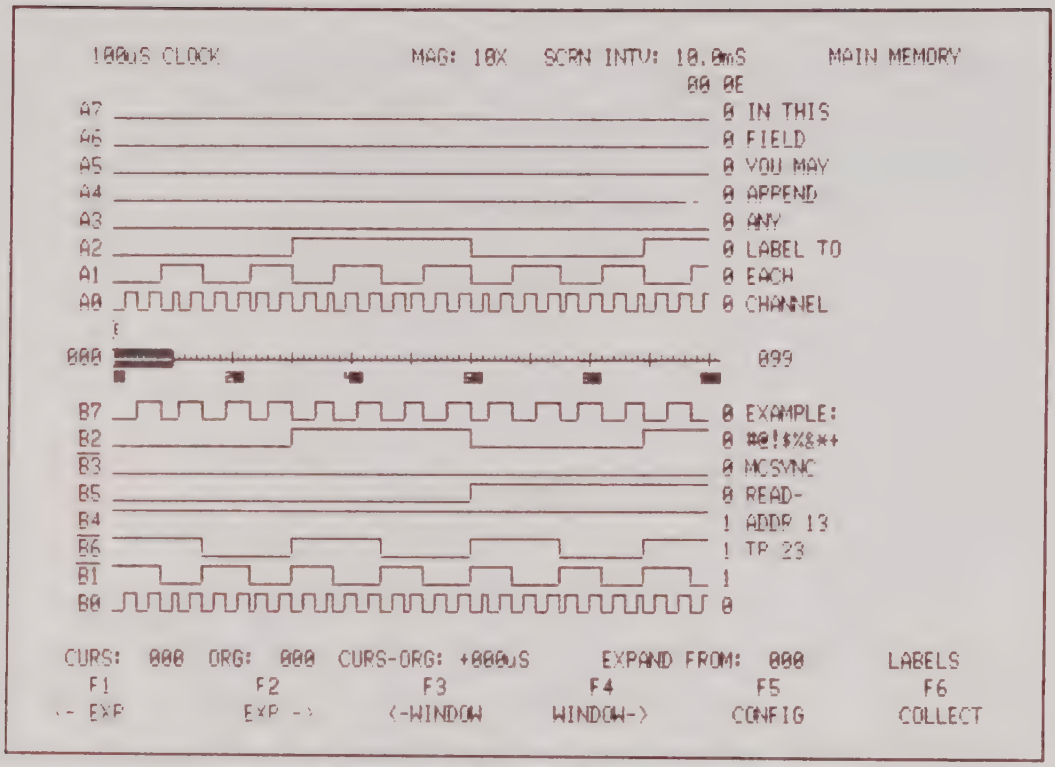

Figure 3-29. Assignment of Labels (NAMES) to Timing Diagram

3.5.24 Trigger

To enter a trigger word, return to trigger field in menu by pressing T. ENTER 00001100 XXXXXXXX. Press F6 to collect data.

Press 1 and then L to move cursor to location 000. Binary values at end of each trace should be those of trigger word entered.

3.5.25 Arm and Trig

With 16-CHANNEL TIMING menu on display and cursor at CLOCK field, use SLOWER key to select 2 millisecond clock.

In this example, both levels of triggering are used. Press S1 and A as a quick way to enter ARM field. Then enter: 0- 0-0-0-0-0-0-0-0 plus 0-1-0-0-1-0-0-0, which is (0048) HEX. Use NEXT key to step down to TRIG field and enter: 0-0-0-0-0-0-0-0 plus 1-1-0-0-1-0-0-0, which is (00C8) HEX.

3.5.26 Triggering Modes

Because two levels of triggering have been set up (ARM an TRIG), one of the triggering modes must be used to specify time delay between these levels. Use PREVIOUS key to access TRIGGER MODE field. Press SELECT key to view following major timing trigger mode options:

TRIG OCCURS 0001 CLOCKS AFTER FIRST ARM

TRIG OCCURS BEFORE 0001 ARMS

Within first two major modes, NEXT and SELECT keys can be used to change TRIG to $\overline{\text{TRIG}}$, > = to < or (blank), BEFORE to AFTER, FIRST to LAST, and ARM to $\overline{\text{ARM}}$.

Set trigger mode to TRIG OCCURS> = 0000 CLOCKS AFTER FIRST ARM. Then use NEXT key to step to DELAY field and set in a delay value of 1501. Trigger mode should now read:

TRIG OCCURS > = 1501 CLOCKS AFTER FIRST ARM.

3.5.27 Pretrigger

Access PRETRIGGER field by pressing S1 and P keys. Use "soft" key INCR to set this field for 50 percent pretrigger (Figure 3-30 shows timing menu up to this point).

```
                    16 CHNL TIMING/STATE  MENU

              2mS CLOCK
 TRIGGER WHEN:
              TRIG OCCURS >= 1501 CLOCKS AFTER FIRST ARM
             CHNL NO. A76543210 B76543210  EDGEQ  FILTER  LINKAGE
ARM (0,1,X):          00000000  01001000    X      OFF     NONE
TRIG (0,1,X):         00000000  11001000           OFF     NONE
PRE-TRIGGER:  50%

                      AAAAAAAA  BBBBBBBB
DISPLAY ORDER (0-7,X): 76543210  76543210
DISPLAY POLARITY (+,-): ++++++++  ++++++++
                           A PROBE            B PROBE
      THRESHOLD:     CH 0-3  CH 4-7  CLK, Q   CH 0-3  CH 4-7
  (-6.4V TO +6.35V)   +1.60   +1.60   +1.60     +1.60   +1.60
  INPUT MODE (S,L):   SAMPL   SAMPL            SAMPL   SAMPL




   S1 - STATE DISPLAY
   S2 - TIMING DISPLAY
  F1         F2         F3         F4         F5         F6
PREVIOUS    NEXT       ( + )      ( - )      CONFIG     COLLECT
```

Figure 3-30. Menu Corresponding to This Example (Thus far)

3.5.28 Status Messages

Press COLLECT and wait several seconds. Notice flashing status messages which indicates what the analyzer is doing as it transitions from SAMPLING to ARMED to TRIGGERED to DONE (relatively slow two millisecond clock allows these messages to be observed).

3.5.29 Pretrigger Memory

To ensure data collection, the NPC-800D does not require a full amount of pretrigger data be collected before the trigger condition becomes satisfied; the amount of data actually preceding trigger point can be less. However, the amount of data following trigger point is always constant for a given pretrigger value.

3.5.30 Trigger Sequence

With timing diagram displayed (at 1X magnification), locate trigger word, 00000000 11001000 (00C8). Notice that the 500 mark on the inverse video graticule at the center of the CRT is at full intensity. This is the location of the trigger word with 50 percent pretrigger set in. When COLLECT key was pressed, the following sequence of events occurred:

1. SAMPLE (Collect Data at two millisecond Intervals)
2. DETECT ARM WORD (0048)
3. START TO COUNT **AT LEAST** 1501 CLOCKS (three seconds +)
4. COLLECT PRETRIGGER DATA (500 Words Prior to Trigger Word)
5. DETECT TRIG WORD (00C8)
6. COLLECT TRIGGER WORD AND FILL REMAINING MEMORY (Trigger word plus 499 Additional Words)
7. DISPLAY (Message Done)
   (Display at 1X magnification is shown in Figure 3-31.)

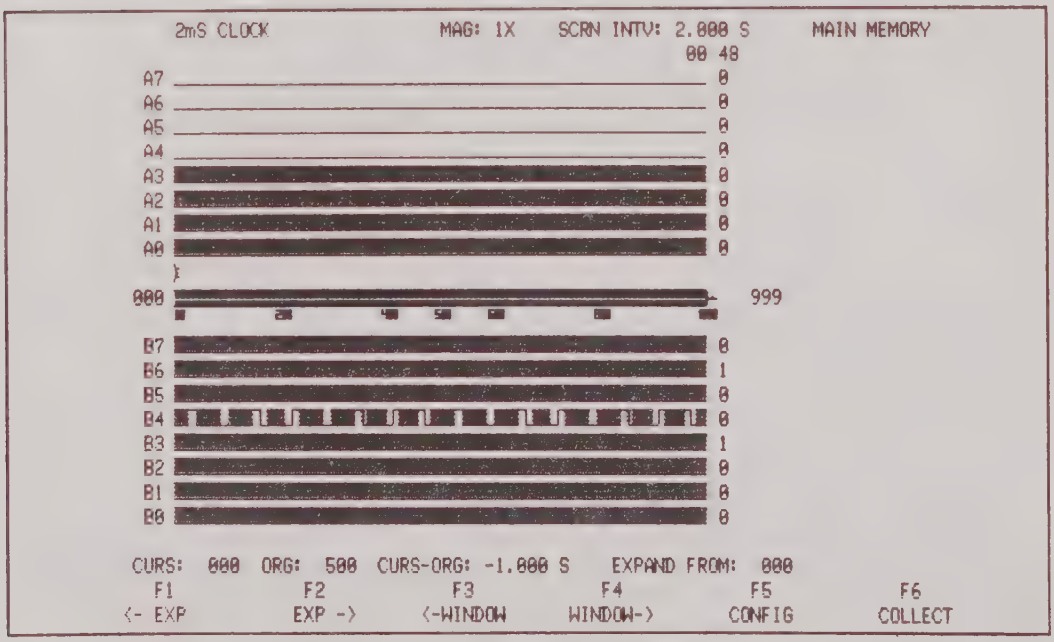

Figure 3-31. Timing Display At 1X Magnification

3.5.31 Correlation (K)

Press SAVE (S) key and observe flashing SAVED message. Press K (CORREL) key to compare main and auxiliary data. A correlation factor of 1.000 is displayed at right of each channel. This factor means that all 1000 bits associated with each main memory channel compares with the 1000 bits in the corresponding auxiliary memory channel on a bit-for-bit basis (see Figure 3-32). Thus, if a correlation factor for .995 is displayed, it indicates 5 bits out of 1000 were different.

NOTE

When K key is pressed, correlation factors replace NAMES. To restore NAMES, press S2.

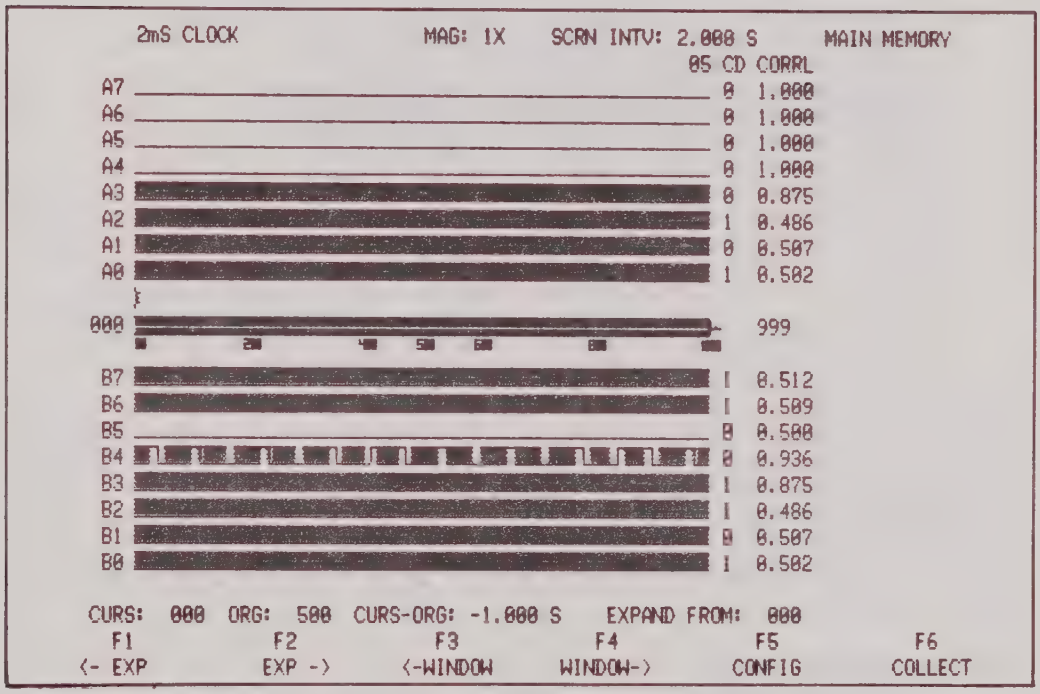

Figure 3-32. A Correlation Factor of 1.000 Means That Data in a Main Memory Channel Precisely Matches Data in Corresponding Auxiliary Memory Channel

Now short out pad labeled 5 on B side of demo card. While holding short in place, press COLLECT. When collection is complete, remove short. To see which channel was affected by short, again press K. The correlation factor for channel B5 is significantly lower than 1.000.

3.5.32 Main/Aux Memory Compare (X)

To view actual effect of short on channel B5, press X (ALT MEMORY) key. As shown in Figure 3-33, channel B5 should cycle between a 1 and a 0. Return to X1 magnification by pressing 1 key.

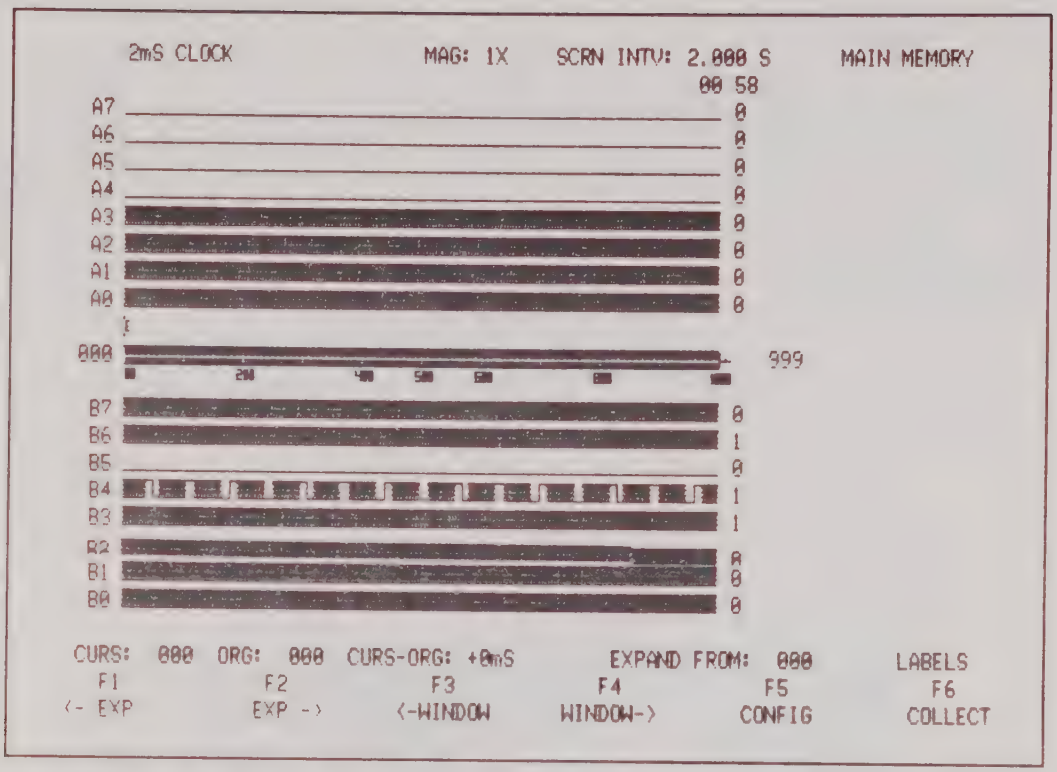

Figure 3-33. MEMORY SELECT Key Used to Observe Effect of Short in Channel B5. (Alternate between main/auxiliary by pressing X key)

3.5.33 Auto Collect

To activate an automatically repeating data collection mode, press CTRL and C simultaneously. Press any ASCII key to stop.

This mode is useful for observing effects to device under test changes, such as those caused by power supply voltages.

3.5.34 Edge Qualification

In the ARM field, combinational logic values (0,1,X) arm (enable) the analyzer for triggering. The EDGE QUALIFIER field (EDGEQ) is used to qualify the ARM (X,⌐,⌙, 0 or 1). Input for this function is on pin 33 located on the timing probe.

To demonstrate this feature, set up timing menu as shown in Figure 3-34. Press F3 key to select a rising edge qualifier. Press F6 and COLLECT data. Now hold shorting wire onto pin 33's input point for the A timing probe. Press F6 again. This time the analyzer does not trigger. Remove shorting wire and analyzer will complete its trigger sequence.

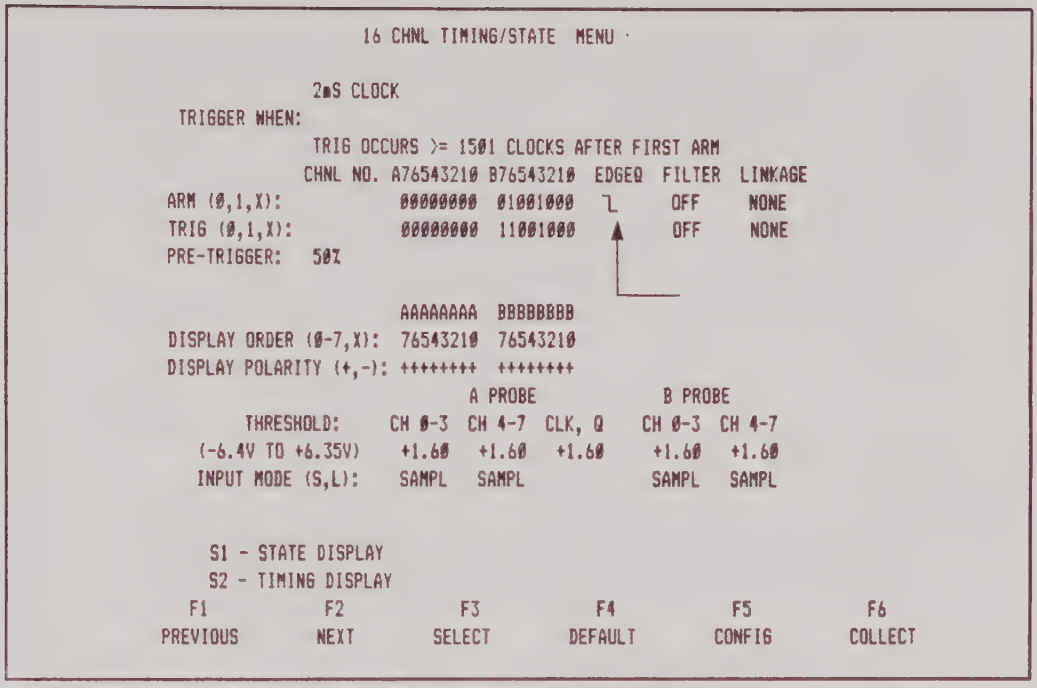
16 CHNL TIMING/STATE MENU
2mS CLOCK
TRIGGER WHEN:
TRIG OCCURS >= 1501 CLOCKS AFTER FIRST ARM
CHNL NO. A76543210 B76543210 EDGEQ FILTER LINKAGE
ARM (0,1,X): 00000000 01001000 ↓ OFF NONE
TRIG (0,1,X): 00000000 11001000 ↑ OFF NONE
PRE-TRIGGER: 50%
AAAAAAAA BBBBBBBB
DISPLAY ORDER (0-7,X): 76543210 76543210
DISPLAY POLARITY (+,-): ++++++++ ++++++++
A PROBE B PROBE
THRESHOLD: CH 0-3 CH 4-7 CLK, Q CH 0-3 CH 4-7
(-6.4V TO +6.35V) +1.60 +1.60 +1.60 +1.60 +1.60
INPUT MODE (S,L): SAMPL SAMPL SAMPL SAMPL
S1 - STATE DISPLAY
S2 - TIMING DISPLAY
F1 PREVIOUS
F2 NEXT
F3 SELECT
F4 DEFAULT
F5 CONFIG
F6 COLLECT

Figure 3-34. Position of Edge Qualification Field in Menu (Options are ↑ , ↓ , 1, 0, and X)

3.5.35 Using The Qualifier

An explanation is apparent after examining Figure 3-35. The A group of bits are those connected to the B side of test card. Channel B0 shows input to pin 33 of A timing probe. To meet triggering specification, it is necessary for ARM word to be seen and input to pin 33 (qualification input channel) to have a rising edge after the last clock and prior to the occurrence of the ARM word. When shorting wire was connected to pin 33, qualification could not be met and the analyzer failed to trigger. Removal of shorting wire allowed the analyzer to complete its sequence. This very useful parameter helps with hardware analysis.

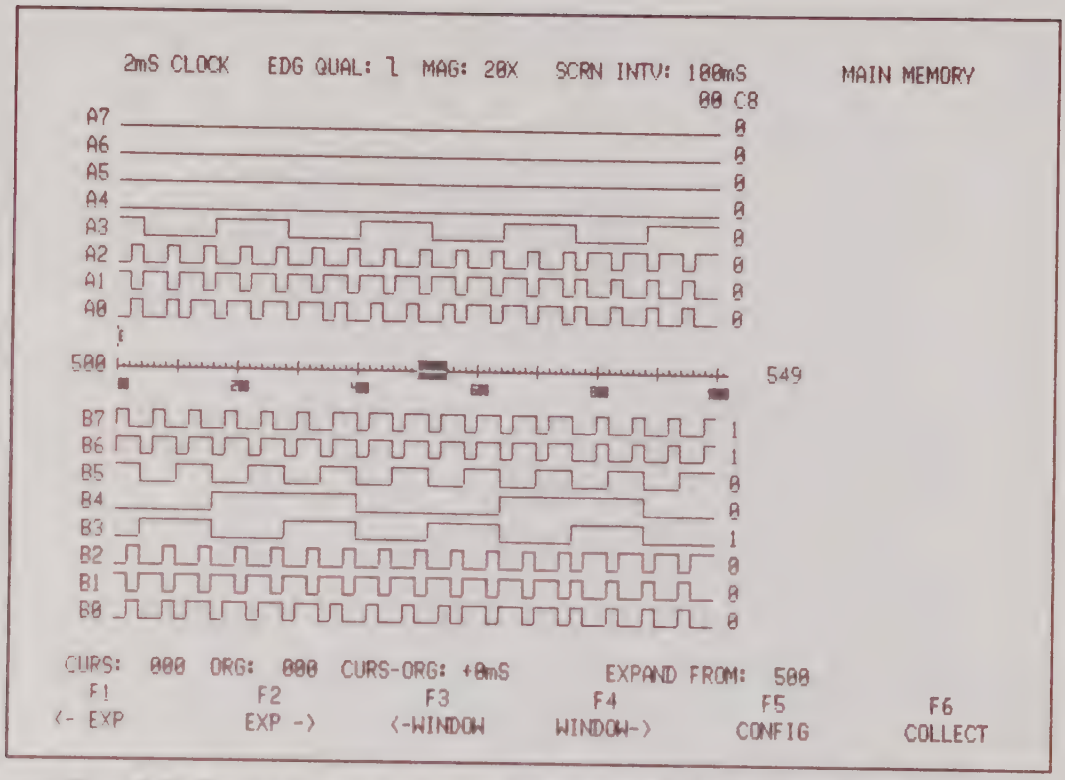

Figure 3-35. Timing Diagram Showing Data Input From Test Card Channels A0-A7 and Input to Edge Qualifier, Pin 33 on the A Probe (Shown as B0 above)

3.5.36 Filter

FILTER sets the number of consecutive clock sample intervals (2-15) during which the ARM word must be stable before it is accepted.

NOTE

Use of 0 or 1 is equivalent to a default value of 1, and turns filter off.

Access ARM field by pressing S2 and the A keys. Then, using NEXT key, step to FILTER field associated with ARM word. Filter fields are used to make certain that associated ARM or TRIG words are stable for 2 to 16 clock sample periods before they are considered valid. This feature avoids generation of false ARM or TRIG words owing to race conditions, propagation delays, or other transient events on the bus.

3.5.37 Threshold

In 16-CHANNEL TIMING mode, threshold level for 16 inputs to the Model 81 probes is keyboard settable in 50 mV increments between −6.40V and +6.35V, in four-channel-bit groups. Clock and qualifier inputs, CLK and Q, on the A probe, are adjustable and are independent of data channels. These features are useful for monitoring ECL logic and mixed logic families. When cursor is located in a threshold selection field, a voltage value within the specified range may be entered, or T automatically selects +1.6 for TTL, and E selects −0.3 for ECL.

3.5.38 Input Mode

The INPUT MODE, sample or latch, refers to the way in which data are recorded.

3.5.39 Sample

In SAMPLE MODE, (default mode), data on input channels are recorded at the occurrence of selected sampling clock edge. Usually, this records expected data. However, occasionally there is a situation where one signal (or more) to be monitored has a very narrow pulse width, relative to other signals to be monitored. If you select a clock speed fast enough to capture this signal, then the time window (for all 1000 words collected) is too small for other channels.

3.5.40 Latch

To eliminate the need for more memory (and expense), the NPC-800D incorporates latching circuitry at the front end of collection hardware. This circuitry is enabled when the LATCH mode is selected.

If there is a transition on any LATCH'ed input line, that value is stored in a buffer and compared to the value on that line at the NEXT sampling clock. If they are different, then the LATCH'ed value is transferred to data memory board rather than sampled value (see Figure 3-36).

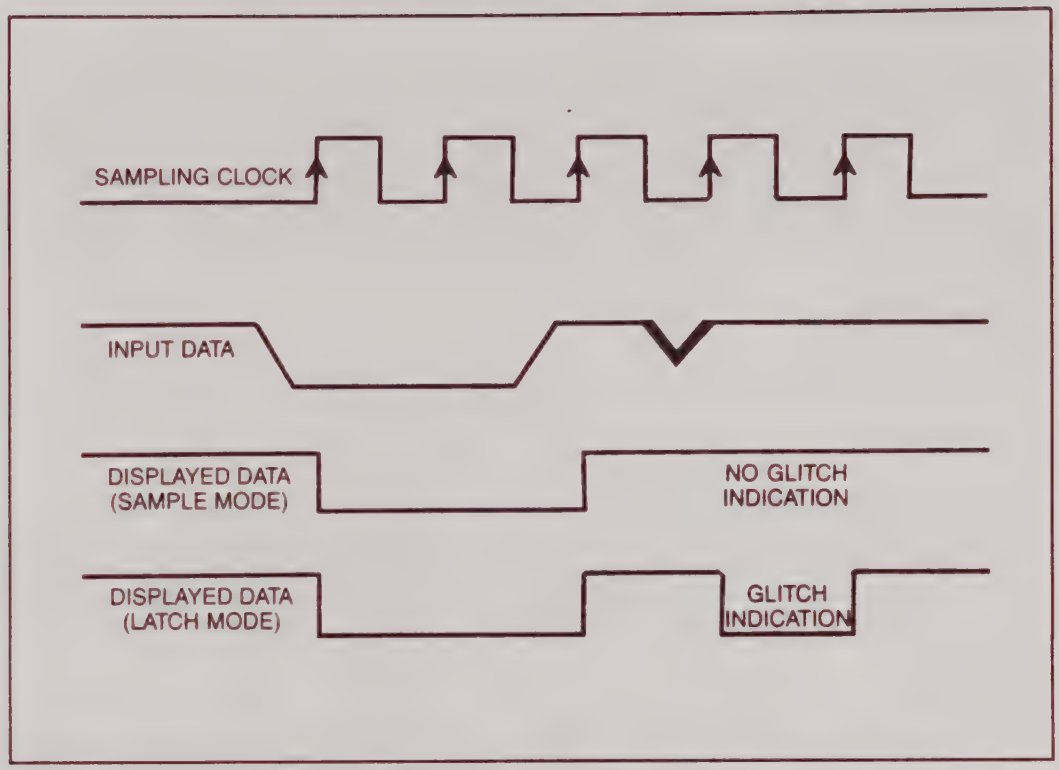

Figure 3-36. Sample and Latch Mode Timing

3.5.41 S1, S2

When using the timing analyzer with an external clock, or monitoring a data or address bus, you may want to view data in state format. As in the state analyzer, you may format data in Hex, Octal, Decimal, Binary, or ASCII. Press LABELS key for prompts.

3.5.42 16-Channel State Display

3.5.43 Collect S1

TO CALL DISPLAY

1. Press COLLECT key to perform data collection.
2. If data have been collected and are displayed in timing format, press S1 to call state display.
3. Press LABELS key, then press one of the display format keys (hexadecimal is used in this example).

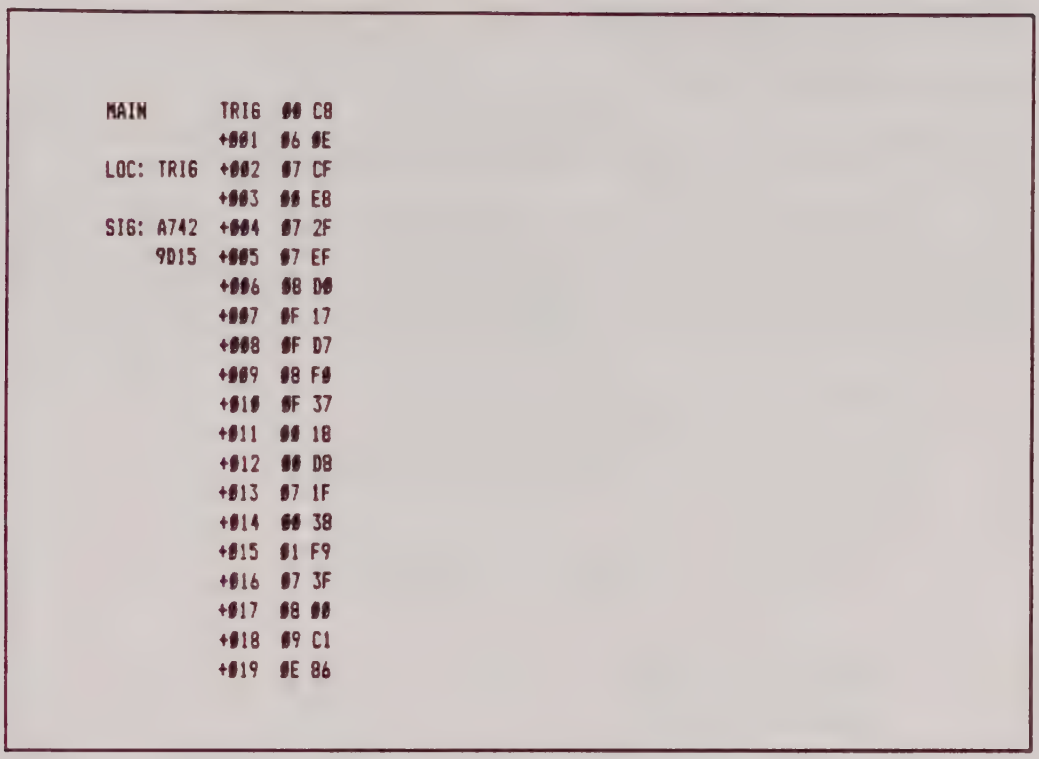

Figure 3-37. 16-Channel State Display

3.5.44 Linkage

Press T to return to trigger field, step cursor to LINKAGE, and press SELECT (see Figure 3-38).

This field is used to link the timing analyzer from events other than timing events. For example, by linking from the state analyzer, you can trigger and collect timing data when your microprocessor begins to execute a specific subroutine.

As shown at bottom right of screen, LINKAGE options are as follows:

W = Analog Waveform Recorder, to trigger on an analog condition (see paragraph 3.10.10).

L = Link to state analyzer and/or BNC connector on back panel labeled LINK (see paragraph 3.5.45).

E = External Input BNC connector on back panel, for linking to other instruments.

3.6 STATE AND TIMING ANALYSIS

3.6.1 Linking State to Timing

To demonstrate the cross domain use of state and timing, reconnect the probes to the test card as follows: A state probe to A side, and A timing probe to the B side.

Reset the Model 800D and select 48-CHANNEL STATE/16-CHANNEL TIMING (configuration number 3). Observe that both STATE (F1) and TIMING (F2) are present on the softkeys. Select state (F1) and define the qualifier setup menu as shown in Figure 3-38. The format is set up to limit the display to only the A probe, clocks are left at default, event one is programmed to 0040 and event two is programmed to be the LINK (see Figure 3-38).

```
                    48 CHANNEL STATE SET-UP

FORMAT:  AAAAAAAA AAAAAAAA XXXXXXXX XXXXXXXX XXXXXXXX XXXXXXXX
          +A HEX
CLOCKS:
    EXT R=( Cr ⌐* Qr X )  S=( Cs ⌐* Qs X )  T=( Ct ⌐* Qt X )
        MEMORY 1: R        MEMORY 2: R        MEMORY 3: R        MASTER:   R

EVENTS:  Qualifiers: -XYZ EL
 E1 0040 HEX =  0040 -XXX XX

 E2 LINK IN  =  XXXX -XXX X1

 E3          =  XXXX -XXX XX                                    H - HEX

 E4          =  XXXX -XXX XX                                    O - OCTAL

 E5          => XXXX                                            Z - DEC

             =< XXXX                                            N - BINARY

    TAB - NEXT SENTENCE                          P - PROGRAM MENU
    S1 - DATA DISPLAY                                           Y - ASCII
   F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT       SELECT      DEFAULT      CONFIG      COLLECT
```

Figure 3-38. State Qualifier Setup for LINK Example

Now display the program setup Menu (Press P) and program it as shown in Figure 3-38.

```
                    48 CHANNEL STATE PROGRAM

EVENTS:     E1 0040 HEX E2 LINK IN  E3          E4          E5

        STOPPING CONDITION: WHEN SEQUENCE DONE
STEP
 1  STORE ALL    . IF 0010 E1 +   THEN GOTO 2 AND LINK. IF       THEN GOTO 1

 2  STORE ALL    . IF 0010 E1 +   THEN GOTO 3 AND LINK. IF       THEN GOTO 2

 3  STORE ALL    . IF 0001 E2 +   THEN GOTO 4  NO LINK. IF       THEN GOTO 3

 4  STORE ALL    . IF 0500 ANY    THEN DONE    NO LINK. IF       THEN GOTO 4

 MORE

     TAB - NEXT SENTENCE      DELETE - BLANK LINES     0 - SETUP MENU
     S1 - DATA DISPLAY
   F1           F2           F3           F4           F5           F6
PREVIOUS       NEXT         INCR         DECR         CONFIG       COLLECT
```

Figure 3-39. State Program to Link to Timing

The Model 800D state analyzer implements linkage somewhat differently than other 800 models. In the illustration (Figure 3-39) we have programmed two of the steps to generate a LINK output. This will be a pulse, valid for one state event time. Step 3 is programmed to advance to step 4 when the state analyzer detects a LINK; the example convolutes the linkage from an output from the state on events and finally as in input to the state to complete its collection. The state's outputs will be used by the timing to result in its trigger; the timing will then latch the LINK which is detected by the state to complete its collection.

Now set up the timing (press S2 then C) as illustrated in Figure 3-40.

```
                    16 CHNL TIMING/STATE  MENU

            100uS CLOCK
 TRIGGER WHEN:
              TRIG OCCURS >= 1501 CLOCKS AFTER FIRST ARM
             CHNL NO. A76543210 B76543210  EDGEQ  FILTER  LINKAGE
ARM (0,1,X):          XXXXXXXX  XXXXXXXX    X      OFF     L
TRIG (0,1,X):         XXXXXXXX  XXXXXXXX           OFF     L
PRE-TRIGGER:  50%

                      AAAAAAAA  BBBBBBBB
DISPLAY ORDER (0-7,X): 76543210  76543210
DISPLAY POLARITY (+,-): ++++++++  ++++++++
                              A PROBE              B PROBE
      THRESHOLD:     CH 0-3  CH 4-7  CLK, Q    CH 0-3  CH 4-7
  (-6.4V TO +6.35V)   +1.60   +1.60   +1.60      +1.60   +1.60
  INPUT MODE (S,L):   SAMPL   SAMPL             SAMPL   SAMPL




   S1 - STATE DISPLAY                                        P -EXT P
   S2 - TIMING DISPLAY                                       N -EXT N
  F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT      SLOWER      FASTER      CONFIG      COLLECT
```

Figure 3-40. Timing Setup with Linkage from State

As shown in Figure 3-40, the first LINK from the state will ARM the timing. Then, after at least 1501 clocks, a second LINK from the state will TRIGGER the timing collection. The 10 microsecond clock selection was made to display timing data at about 25 samples per transition of the fastest datum; this yields a display with good timing resolution and also assures that the LINK condition will be present on the clock edge; if the timing clock is too slow, the LINK may not be present consistently.

3.6.2 Collect Data

Press the COLLECT key. On completion, press the CTRL C to auto-collect. The timing display is illustrated in Figure 3-41. You should observe the status line which shows the STATE step 1, then 2, then 3 and finally done. The timing status shows: TIMING sampling, then armed, then triggered, and then done: the triggered message has about one millisecond duration and is probably not visible. Because of the auto-collect, as soon as the timing waveforms are displayed, the collection is restarted. The following occurs for each collection:

STATE	TIMING
STEP 1	SAMPLING
STEP 2	ARMED
STEP 3	TRIGGERED
STEP 4	DONE
DONE	

3.6.3 How the Linkage Works

In step 1 of state, the analyzer must collect event 1 (0040XX...X) ten times. The state then outputs a LINK pulse and advances to step 2. The timing analyzer sees the lINK which is its ARM event. The state, in step 2, then must collect event 1 ten more times; it again outputs a LINK pulse and advances to step 3. The timing analyzer sees this LINK as its TRIGGER event performs the next 1000 samples (the pretrigger is 00) to complete its collection. The timing analyzer's trigger is latched to drive the LINK true; the state analyzer sees the event, collects 500 more samples and is done. The data are then displayed. To display the state collection, stop the auto-collect by pressing the SPACE bar, wait for the current collection to complete, then press S1. To redisplay the timing, press S2.

3.6.4 Data Displays

Figure 3-42 illustrates the state data resulting from the cross-linked collection. Note that in Figure 3-41 a 50 percent pretrigger was used and that the data window illustrated contains the trigger point at location 500. The state data illustrated are also centered about 500; the state was set up to complete after collecting 500 samples after detecting the LINK (i.e., after the timing triggered).

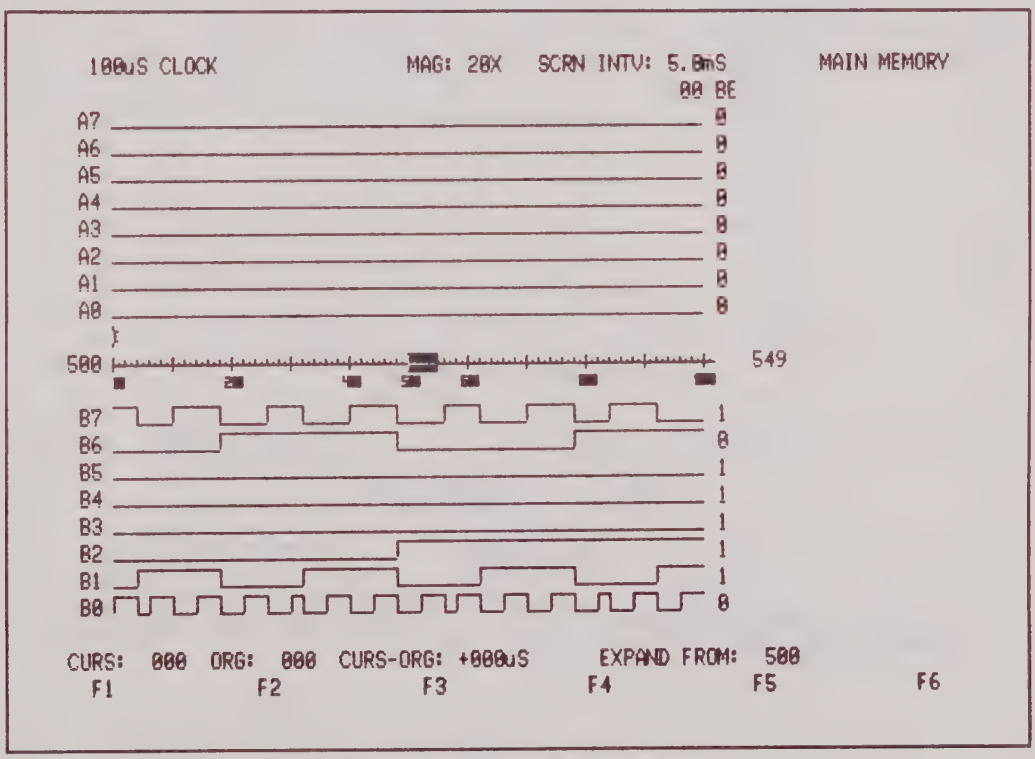

Figure 3-41. Linked Timing Display

3.6.5 Applications of Cross Domain Analysis

As shown in Figure 3-41, the example is a complex but very useful way to use the power of the Model 800D. Consider a process control application for example. Linking the program event to trigger the timing provides a simple way to monitor the control signals generated. Linking the timing to the state, conversely, provides a simple way to monitor the program behavior following an event that results in an interrupt. In a later section, there is an example that links the waveform to and from the state. For additional information, refer to Application Note entitled "Linking Resources in NPC-800 Series Logic Analysis Systems."

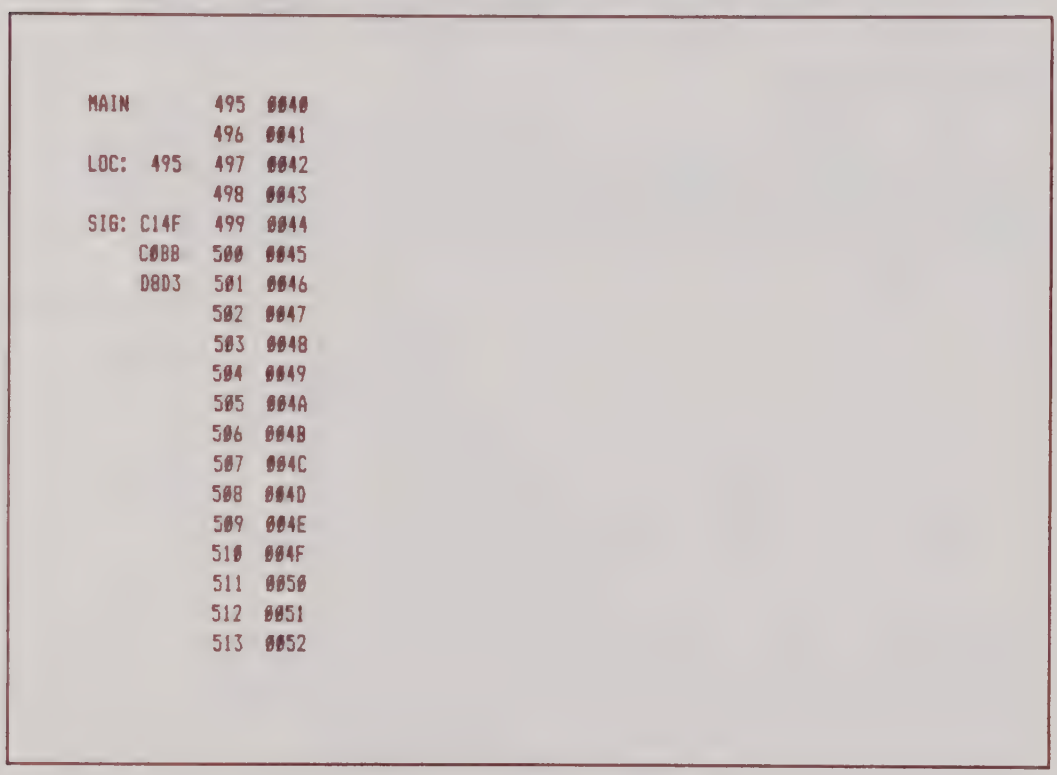

Figure 3-42. State Linked Data

NOTE

Linkage conditions should not be set in both analyzers simultaneously because neither analyzer will trigger.

3.7 GLITCH CAPTURE

3.7.1 Eight-Channel Glitch Memory Mode

The NPC-800D's 8-CHANNEL GLITCH MEMORY mode allows you to capture 3 nanosecond glitches and display them along with 8 channels of data. It is important to distinguish between this mode and the conventional 3-nanosecond glitch latch capabilities of the previously described 16-channel timing configuration (which does not incorporate a separate glitch memory). In the conventional 3-nanosecond latch mode, the analyzer arms a latch to capture any transitions occurring before the next sample clock edge. If a transition does occur, the latch is set and sampled at next clock edge. For a narrow glitch, whose width is less than the clock sample period, the display shows the glitch as one clock-period wide.

3.7.2 Hardware

In the Glitch Capture mode, the NPC-800D uses two adjacent input lines to store timing information in one memory, and glitch information in the other memory. To eliminate connecting two inputs to your circuit, a terminator, M83, for dual threshold setups is provided with each timing probe (in this example for glitch capture).

Glitches of three nanosecond duration or longer, which occur between sample clock edges, are stored in separate glitch memory. Upon display, a glitch is shown as a vertical line interspersed with data (see Figure 3-44).

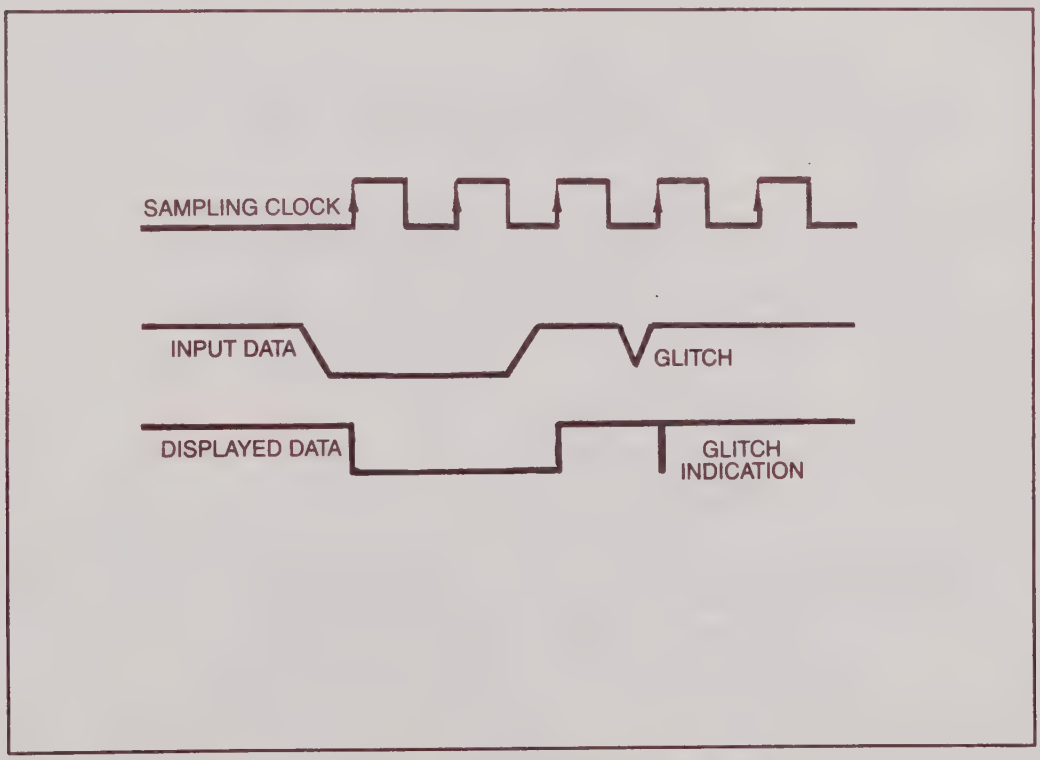

Figure 3-44. Glitch Interspersed With Data

3.7.3 Setup

Press RESET key. Select 8-CHANNEL TIMING GLITCH mode from CONFIGURATION LIST. Set in a clock speed of one millisecond.

3.7.4 Connect

Connect M83 to A timing probe; then install microhooks on to the A0 channel. Attach microhook to pin 3 of U2 on test card. To provide power to circuitry, connect A state probe to A side of test card.

3.7.5 Collect S2

Press COLLECT to take a data collection. With timing data displayed as X20, move window (if necessary) to obtain a display similar to Figure 3-45. Notice glitch indications on channel A0. Because the definition of a glitch is any transition which occurs between sample clocks, the use of relatively slow (1-millisecond) clock allows "glitches" to be viewed. If you don't get at least one "glitch" on channel A0, press COLLECT again or use a 2-millisecond clock.

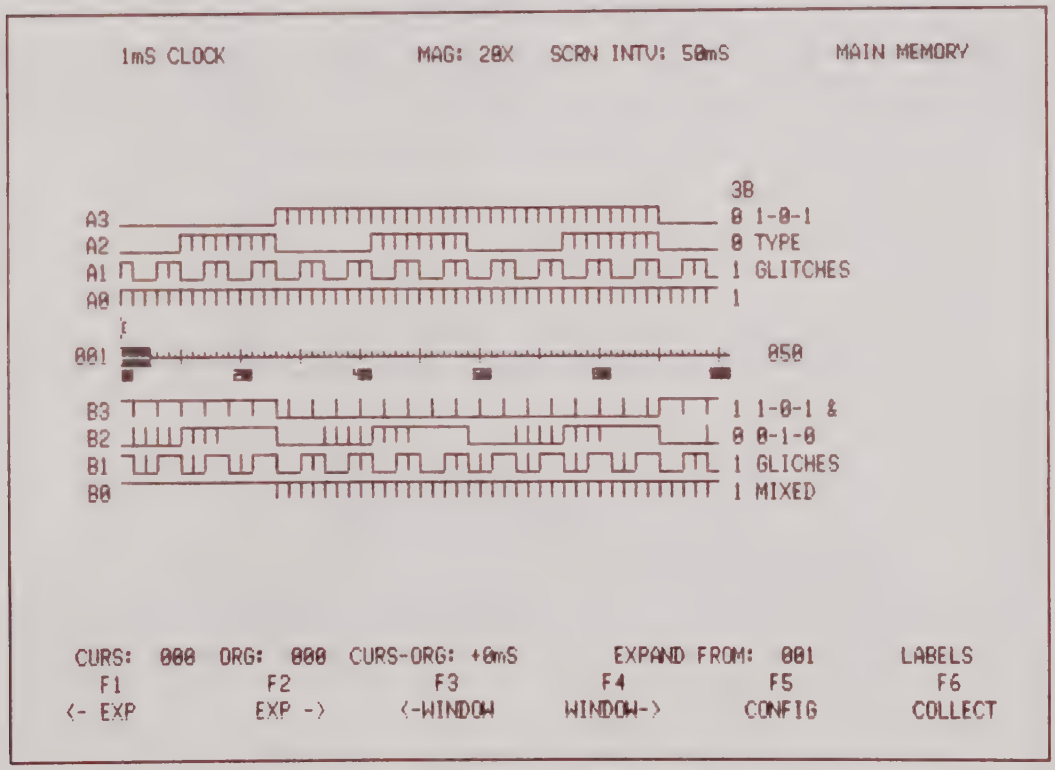

Figure 3-45. Timing Display With Glitches
(Your display will differ since no trigger word was specified)

3.8 75MHz SYNCHRONOUS ANALYSIS

3.8.1 External Clock

The NPC-800D has one of the fastest synchronous collection speeds available.

This example uses an external clock with the timing analyzer. Maximum clock rate is 75 MHz. Press RESET, select 16-Channel Timing, S2 and C key to get into clock field in timing menu. Using P or N key (note prompt at lower right of screen), select an external clock with a rising or falling edge. One bit, which is available for clock qualification, can be used by connecting qualifying channel to line 33 on A probe and setting 1 or 0 in menu field. Press COLLECT key and note changes to timing diagram: clock specification is now external clock, and time difference is now measured in clock cycles(CS) (see Figure 3-46).

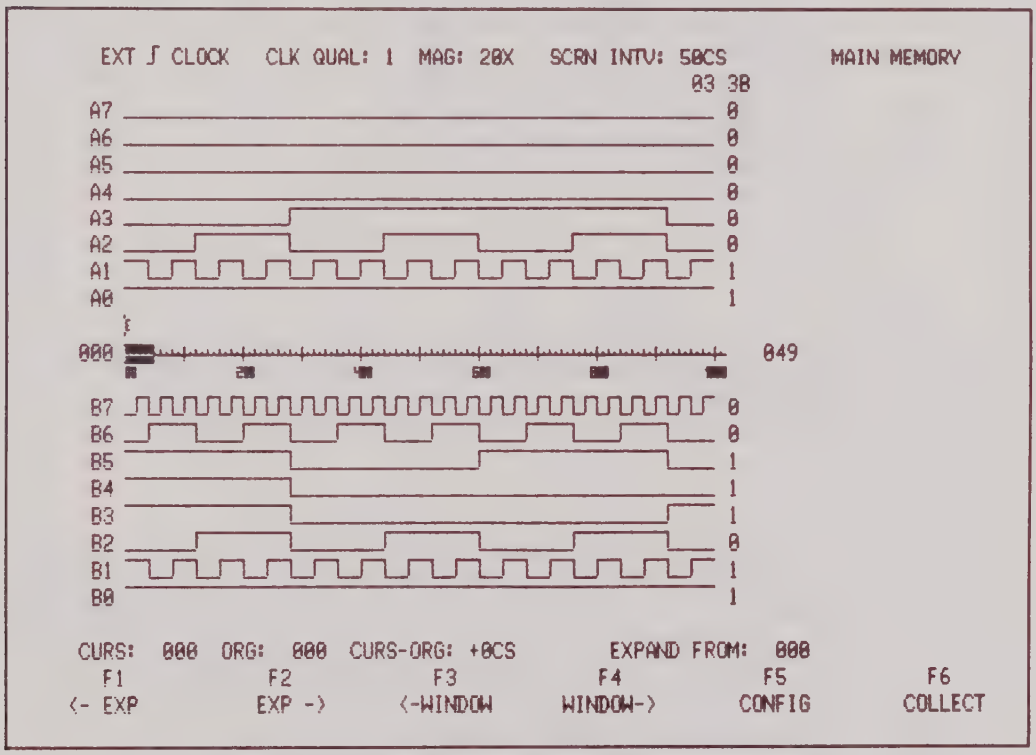

Figure 3-46. Timing Diagram Using An External Clock

You still have all of the trigger capabilities and display manipulation features discussed earlier. For example, in this mode you probably want data displayed in state format. Press S1 to switch format, then press LABELS for prompts for valid keystrokes. Press S1 to view data in state format.

```
MAIN        TRIG  03 3B
            +001  03 BB
LOC: TRIG   +002  01 79
            +003  01 F9
SIG: A49A   +004  03 7B
     A0D6   +005  03 FB
            +006  05 3D
            +007  05 BD
            +008  07 3F
            +009  07 BF
            +010  05 7D
            +011  05 FD
            +012  07 7F
            +013  07 FF
            +014  09 01
            +015  09 81
            +016  0B 03
            +017  0B 83
            +018  09 41
```

Figure 3-47. High Speed Synchronous Data Displayed In State Format

3.9 FREQUENCY COUNTER/INTERVAL TIMER/SIGNATURE ANALYZER

3.9.1 CT/SA

The Frequency Counter/Interval Timer/Signature Analyzer is an optional circuit board that installs inside the NPC-800D. It comes with a standard oscilloscope-type probe, and is used to measure frequency, period, intervals, total count of events, or single-node signature analysis of serial data. It is very useful in verifying time-domain parameters of your digital system. For example, you can measure the time a software subroutine takes to execute.

3.9.2 Histograms

This hardware, which also is used with the Performance Analysis software option, displays bar charts of overall system operation/performance.

3.9.3 Basic Counter-Timer/(Optional CT/SA Board Must Be Installed)*

To demonstrate basic features of the optional counter-timer and signature analysis functions of the NPC-800D, the Model 90 probe is used to monitor signals on the test card. Connect probe to rear panel input connector labeled CTSA. Set Model 90 probe for X10 operation.

3.9.4 Counter-Timer Menus

Three illustrative counter-timer menus are shown Figures 3-48, 3-49 & 3-50.

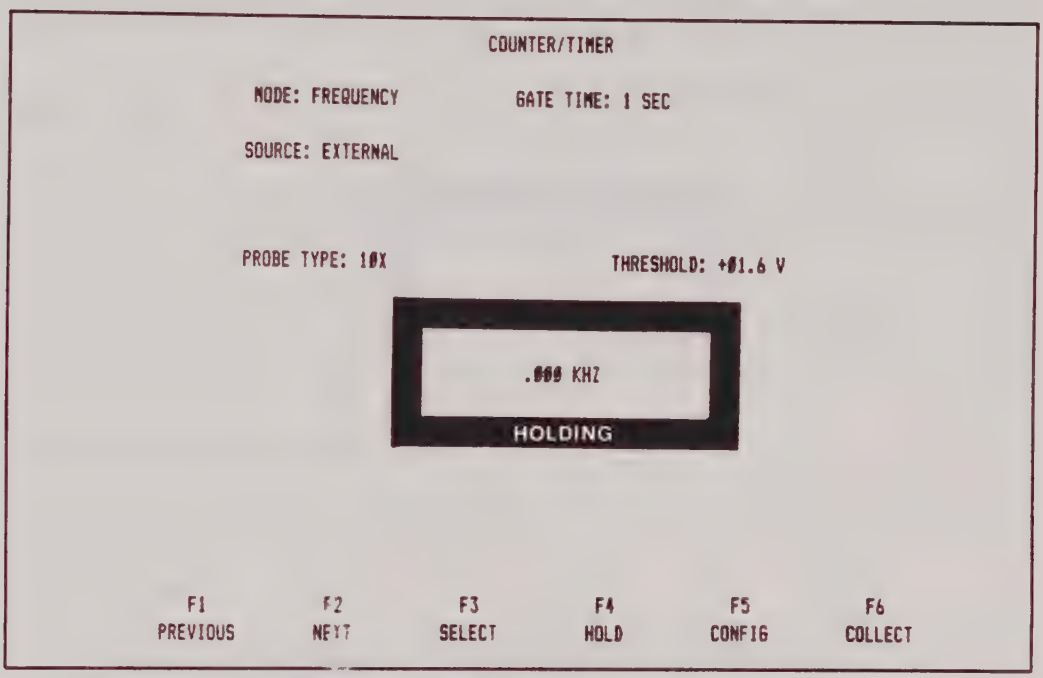

Figure 3-48. Frequency Mode With External As Source (Using Model 90 probe)

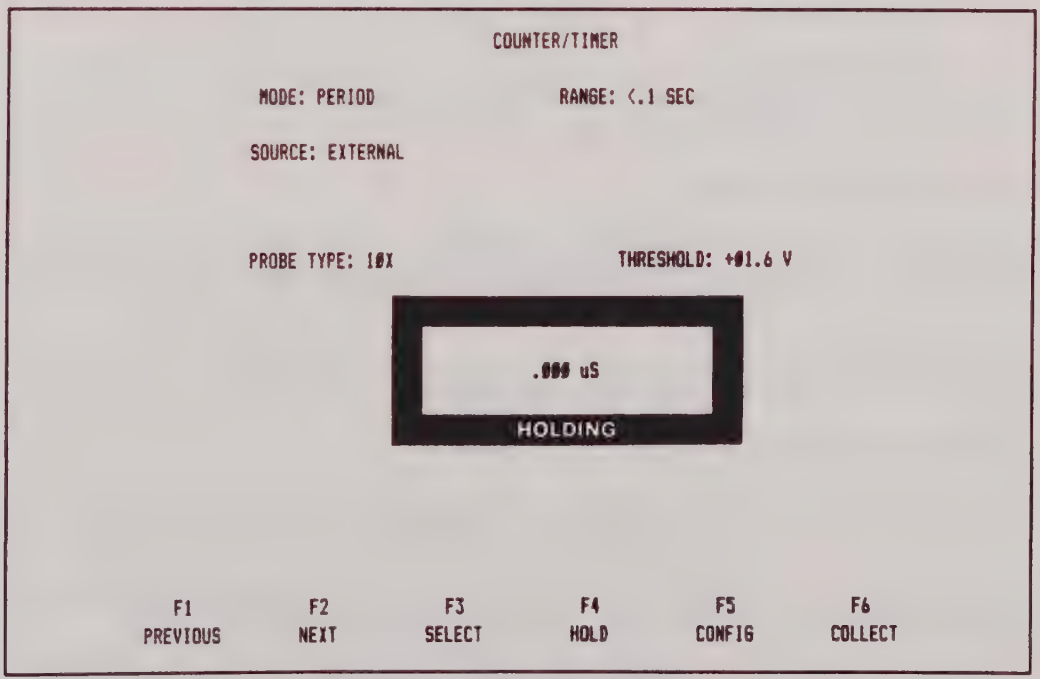

Figure 3-49. Period Mode With External Source (Using State Probes; Total Mode Is Similar)

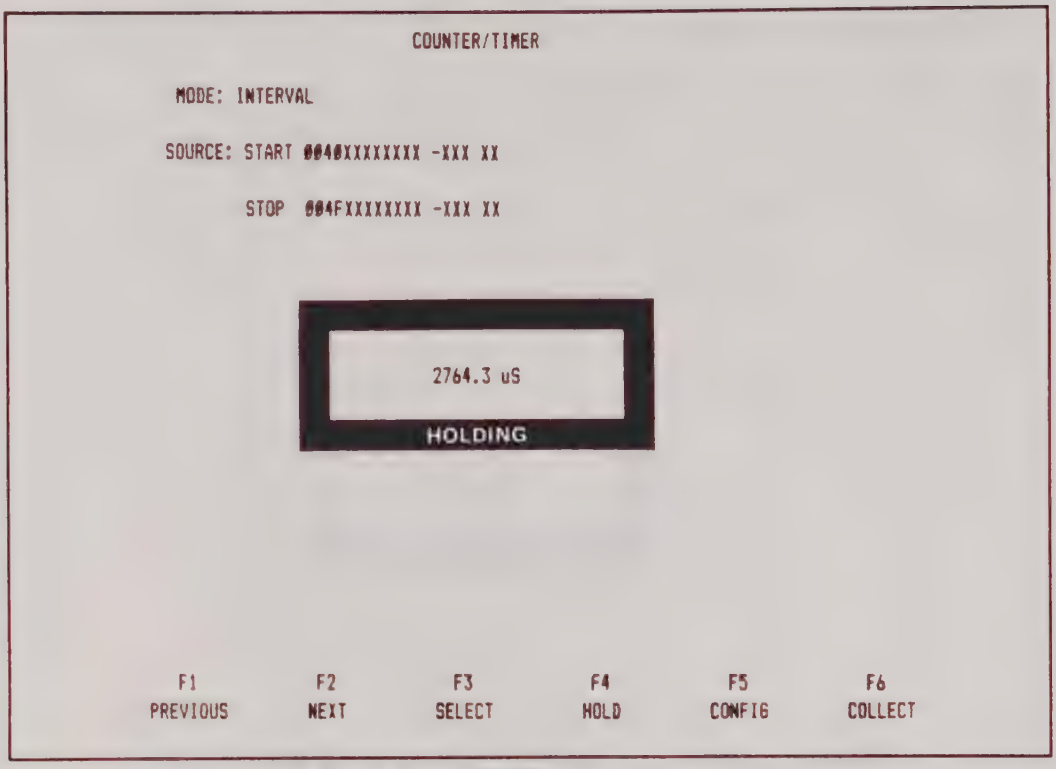

Figure 3-50. Interval Mode With State Data Probes As Source

3.9.5 To Call Up Menu

1. Press RESET key.
2. Press SEL DOWN or SEL UP key to select COUNTER-TIMER Mode.
3. Press SELECT (F1) key to call the menu.

3.9.6 Explanation Of Menu

The user can select from the following counter-timer modes: FREQUENCY, PERIOD, INTERVAL, and TOTAL. Measurements can be made of individual signals using the Model 90 scope probe or of state events using the analyzer's 16-channel state probes.

FREQUENCY mode: measures individual signals up to 100 MHz using the Model 90 probe. Using the 16-channel state probes, this mode can measure state events up to 10 MHz.

PERIOD mode: inverse of FREQUENCY mode.

TOTAL mode: measures total number of occurrences of single events monitored by the Model 90 probe, or state events monitored by 16-channel state probes.

GATE TIME: used in FREQUENCY mode only. GATE TIME is time interval over which frequency is measured and can be selected from 10 milliseconds to 10 seconds.

RANGE: used in PERIOD mode only. RANGE is maximum period which can be measured and can be selected from 10 milliseconds to 10 seconds.

SOURCE: in FREQUENCY, PERIOD, AND TOTAL modes, the SOURCE field can be selected as EXTERNAL (Model 90 probe), PRESCALE (EXTERNAL/10), or DATA (state probes). PRESCALE mode must be selected for measurements above 10 MHz (100 MHz maximum). DATA mode allows measurements to be made on state events up to 56-bits wide.

INTERVAL mode: SOURCE field allows specification of START and STOP words, each 38-56 bits wide.

PROBE TYPE: this field is displayed only in FREQUENCY, PERIOD, and TOTAL modes, and only when SOURCE field is EXTERNAL or PRESCALE (EXT/10). Depending on the setting of the Model 90 probe switch, the two options are 10X and 1X.

THRESHOLD: this field is available only when the PROBE TYPE field is displayed. When a 10X probe type is selected, the threshold for an incoming signal can be set between −25.4V and +25.6V, in 0.2V increments. When a 1X probe type is selected, the threshold can be set between −2.54V and +2.56V, in 0.02V increments.

3.9.7 Basic Counter/Timer Example

This section illustrates the use of the NPC-800D to make frequency (or period) measurements and totalize events using the Model 90 probe.

3.9.8 Menu

Press CONFIG key and step down to COUNTER-TIMER mode. Then press SELECT key to display COUNTER-TIMER menu (see Figure 3-51).

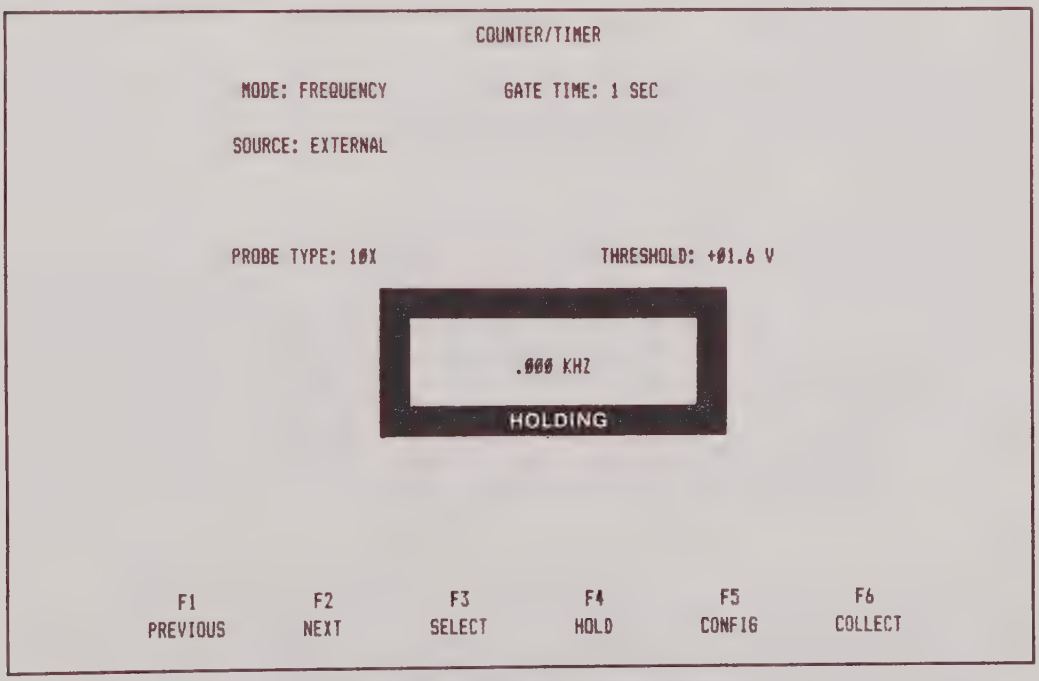

Figure 3-51. COUNTER-TIMER Menu

*Rectangular display window is blank if CT/SA option is not installed.

3.9.9 Counter-Timer Display

The counter-timer display is incorporated into the menu. To measure a signal, simply connect appropriate probe(s). Frequency, time, or count of input events appears in rectangle on screen. Also, message COLLECTING appears below reading to indicate real-time nature of current measurement. To "freeze" measurement, press HOLD (F4) key; message HOLDING then appears below reading.

3.9.10 Advanced Counter-Timer Example

In addition to the basic use of the counter-timer to measure simple events using the Model 90 probe, the NPC-800D can be used to make counter-timer measurements of bus or other state events as monitored by three-state probes.

3.9.11 State-Related Measurements

Frequency, period, and count measurements can be made by specifying a cyclical or repeating data word or event; interval measurements can be made by specifying two data words or events. For both, the data word can be specified as having up to 53 bits. These include 48 bits of data from A, B, and C channel probes and five additional bits of data and linkage qualifiers: three from A, B, and C channel probes (XYZ), one external BNC bit (E), and one linkage bit (L). The following procedure illustrates the use of the counter-timer for state-related measurements. As before, A state probe should be plugged into A side of test cards.

3.9.12 Frequency

Using F1 or F2, move to mode field and select frequency with F3 key.

3.9.13 Source: Data

Next, step cursor to SOURCE field and select DATA. When DATA is the source, the field for data word is automatically displayed in the format previously selected in the state menu. Then enter data word: 0040 (the rest Xs) (see Figure 3-52).

3.9.14 Collect

Press COLLECT key to begin counter-timer. Display indicates frequency of occurrence of specified data word being monitored by A probe (remaining bits of B and C channel probes are set to DON'T CARE as are the qualifier bits XYZ EL). Pressing HOLD (F4) key causes last measurement to be held on display. Pressing COLLECT causes counter-timer to resume making measurements.

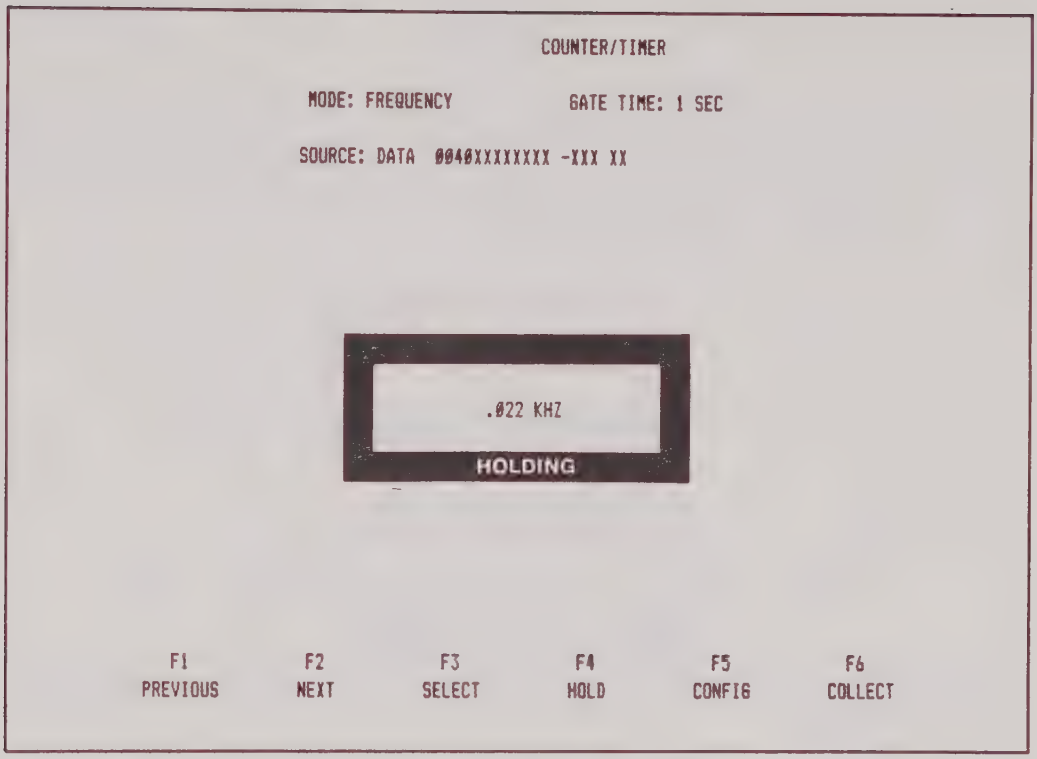

Figure 3-52. Counter-Timer Display Indicating Frequency of Occurrence of Specified Data Word

3.9.15 Select

Move cursor through menu and back to MODE field. Counter-timer remains functioning and collecting even while cursor is moved within menu. Press SELECT key to change modes to PERIOD, INTERVAL, and TOTAL and also to watch the Display Reflect mode that is selected.

As in the basic counter-timer example, pressing HOLD key holds measured data; while pressing COLLECT key restarts measurement.

3.9.16 Interval Mode

All modes with the exception of INTERVAL only require a single event. As the name implies, INTERVAL refers to the time between two events and thus requires two data words: START and STOP. When INTERVAL mode is entered, the fields for two data words are displayed. The fields are identical to those of the single data word, 48 bits plus 8 additional qualifiers.

3.9.17 Collect

Select INTERVAL mode and step cursor to SOURCE field. Enter 0040 (the rest Xs) and 00FF (the rest Xs) in START and STOP fields, respectively. When finished, press COLLECT key and watch display indicate interval (in microseconds) between the two data words (see Figure 3-53). The interval timer continues making and displaying measurements until HOLD key is pressed.

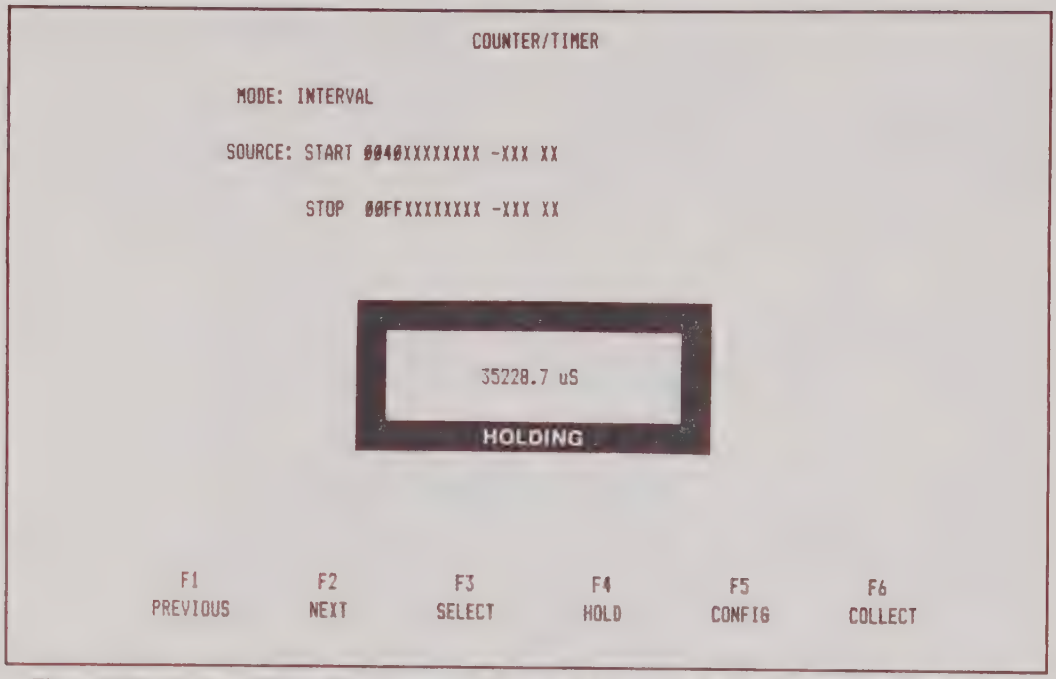

Figure 3-53. Counter-Timer Measurements of Interval Between START and STOP Data Words

3.9.18 Frequency

You're now ready to make a frequency measurement. Hold probe on data line DB0 located on test card (A channel side); watch NPC-800D as it displays frequency (see Figure 3-54). The message COLLECTING, which appears under counter-timer display, indicates NPC-800D is in a Real-Time Measurement mode. Press HOLD (F4) to hold a particular reading.

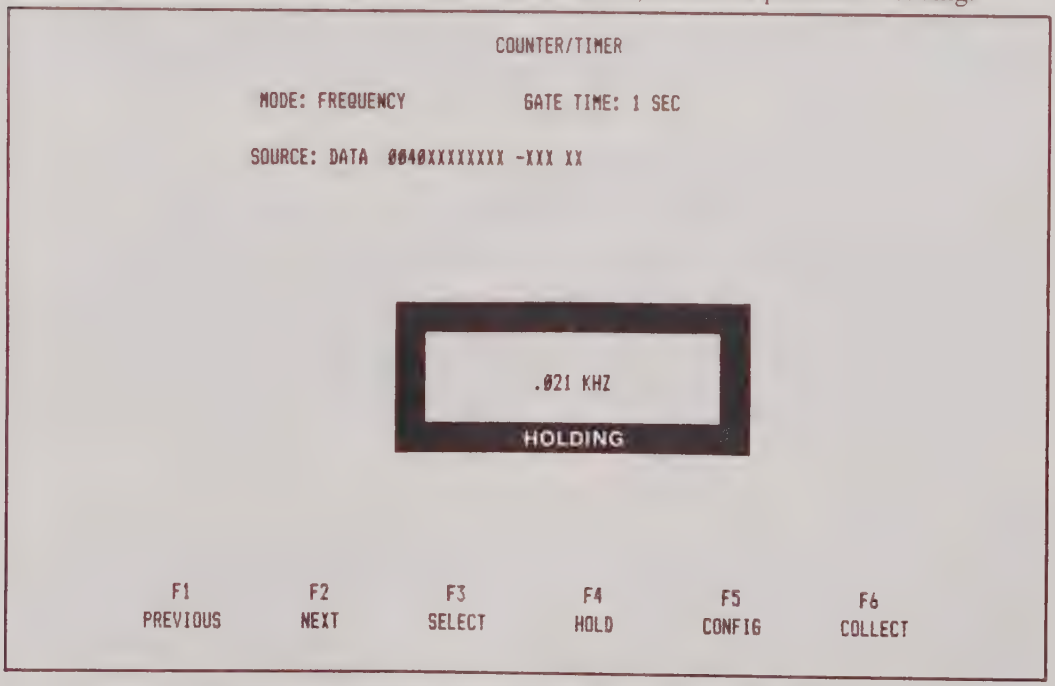

Figure 3-54. Frequency Measurement Using Counter-Timer

3.9.19 Period

With cursor in MODE field and probe still on DB0, use SELECT key to change mode to PERIOD. Display now measures in units of time (microseconds) instead of frequency (kHz). GATE TIME field changes to RANGE when mode is changed to PERIOD. GATE TIME indicates interval over which frequency is measured and also interval between display updates. RANGE indicates maximum period which can be measured (see Figure 3-55).

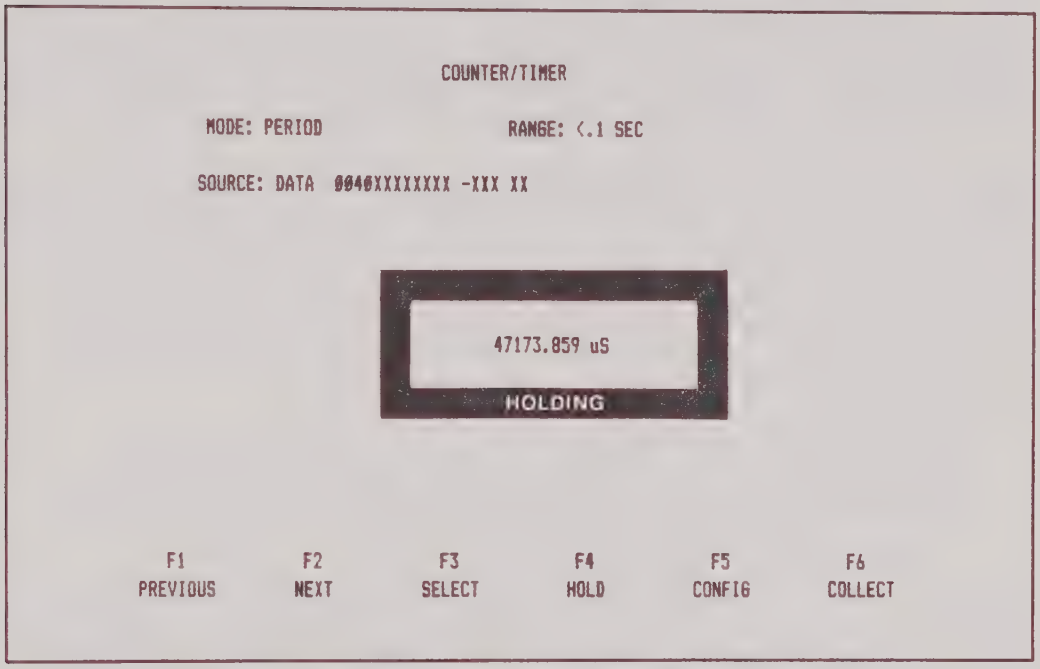

Figure 3-55. Period Measurement Using Counter-Timer

3.9.20 Hold

Next, press HOLD key (F4). This causes display to hold last measurement and displays the message HOLDING under the value. Press COLLECT key to restart counter-timer. The message COLLECTING again appears under counter-timer display.

3.9.21 Probe And Threshold

The other two parameters, which were used (PROBE TYPE and THRESHOLD) set the input signal voltage range. If probe setting and menu are both set to 1X, the range of threshold settings which can be used is anywhere from −2.54V to +2.56V, in 0.02V increments. With a probe setting of 10X in the menu, and the Model 90 probe set to X10, the range of threshold voltages is from −25.4V to +25.6V, in 0.2V increments.

3.9.22 Basic Signature Analysis (Example)

This section illustrates basic signature analyzer features of the optional Counter-Timer/ Signature Analyzer board. The NPC-800D can be used to perform the function of a traditional signature analyzer (Hewlett Packard 5004A or equivalent) which uses individual lines for start, stop, data and clock signals.

3.9.23 Discussion

Briefly, signature analysis is a troubleshooting technique that uses a data compression algorithm to reduce a complex, serial data stream to a unique 4-digit signature. To develop a signature, a START event, STOP event, CLOCK, and a serial data signal are required. In most signature analyzers, each of these signals requires a single line connected to the circuit board being tested.

By comparison, the NPC-800D allows the use of up to 53 bits to define START and STOP events. The CLOCK signal is specified in the state menu (The data lines and qualifiers should be valid on the appropriate master clock edge). The serial data signal is provided through the Model 90 probe connected to the rear panel input connector labeled CTSA.

For testing logic other than TTL (for example, ECL), NPC-800D's signature analyzer allows variable-threshold signal levels to be input to the serial data probe. By using the analyzer probes adjustable threshold feature, it also allows a variable threshold implementation of START, STOP, and CLOCK signals.

3.9.24 Signature Menu

3.9.25 To Call Up Menu

1. Press CONFIG or RESET key.
2. Press SEL DOWN or SEL UP key to select SIGNATURE ANALYZER mode.
3. Press SELECT (F1) key to call menu.

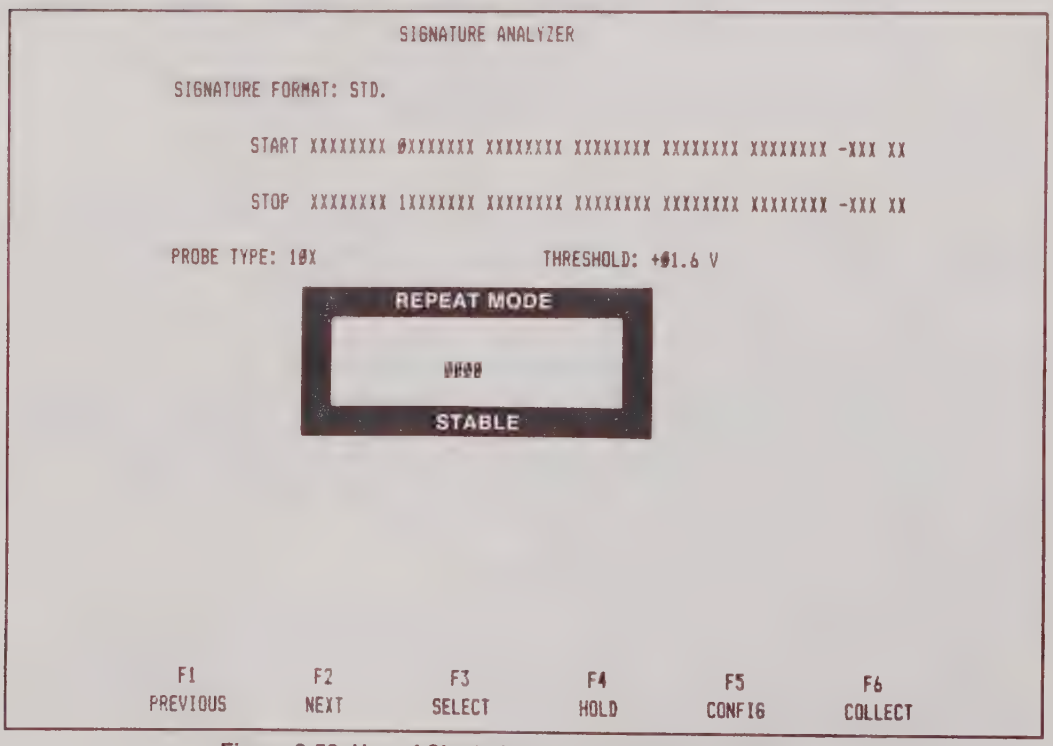

Figure 3-56. Use of Single Bit START and STOP Words

3.9.26 Explanation of Menu

SIGNATURE FORMAT: two formats can be selected, STD or HEX. STD format uses the 7-segment alphanumeric type of display of the HP-5004A Signature Analyzer (0-9, A, C, F, H, P, U). HEX format displays signatures in hexadecimal (0-9, A-F).

START AND STOP: START and STOP words gate the serial bit stream coming through the Model 90 probe. A logic zero in any bit position corresponds to (:) on the HP-5004A; while a logic one corresponds to (:).

START and STOP Words: automatically formatted in accordance with the user's display format in the 48-channel state menu. A single format can be selected using HEX, OCT, BIN, DEC, or ASC keys.

PROBE TYPE: To match corresponding settings of the Model 90 probe, two options are provided, 10X and 1X.

THRESHOLD: when a 10X probe type is selected, the threshold for an incoming signal can be set between −25.4V and +25.6V, in 0.2V increments. When a 1X probe type is selected, the threshold can be set between −2.54V and +2.56V, in 0.02V increments.

NOTE

In a typical application, the clock used in conjunction with the serial bit stream being monitored should be derived from the A state probe. Set this clock for a rising or falling active edge in the state menu as appropriate.

SIGNATURE DISPLAY: incorporated into the menu, it takes a signature of a serial bit stream being monitored by the Model 90 probe. Simply touch probe to node and press COLLECT key.

3.9.27 To Setup Menu

3.9.28 Start/Stop

Using NEXT or PREVIOUS keys (as required), move cursor to START field. START word is always displayed in the format used in the state menu. Press N (Binary) key to display START word in a binary format. Next, enter single-bit START word (0) in ninth bit position from left. Press NEXT key to move to STOP field. Then press N (Binary) key and enter single-bit STOP word (1) in the same position as before (see Figure 3-57).

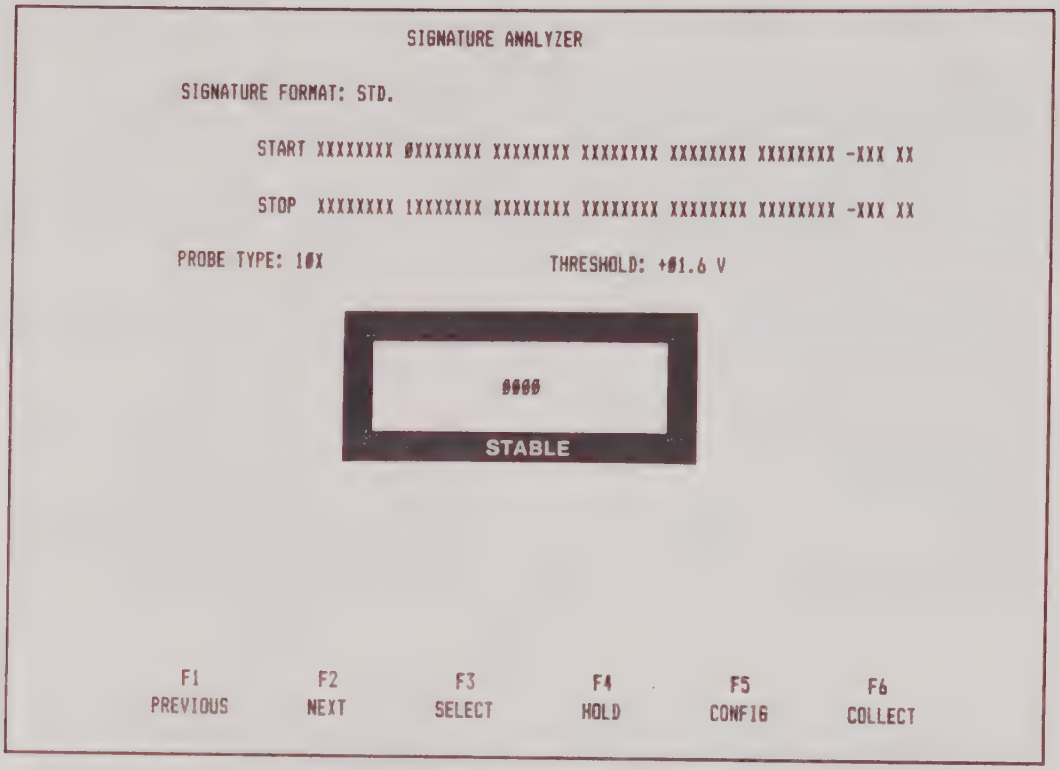

Figure 3-57. Use of Single Bit START and STOP Words

Connect A and B state probes to test card's A and B outputs. Press COLLECT key. A signature can now be taken for any serial stream on the test card in the interval between single-bit START and STOP words.

3.9.29 Signatures

When you want to take a signature of a test point, simply touch the circuit node of interest. For example, touch the Model 90 probe tip to the B channel data lines (labeled DB0-DB7), one at a time; the NPC-800D automatically displays the signature of the data line being tested (see Figure 3-58).

Each time you take a serial collection resulting in a new signature, the display underneath the signature reads UNSTABLE (changing) for approximately a second, then switches to STABLE. However, if the signature collection is the same for successive measurements, only the message STABLE is displayed.

The signature window displays REPEAT MODE above the signature. This is the Automatic mode mentioned above. Press HOLD (F4) key to hold displayed signature; press COLLECT key to return to automatic mode.

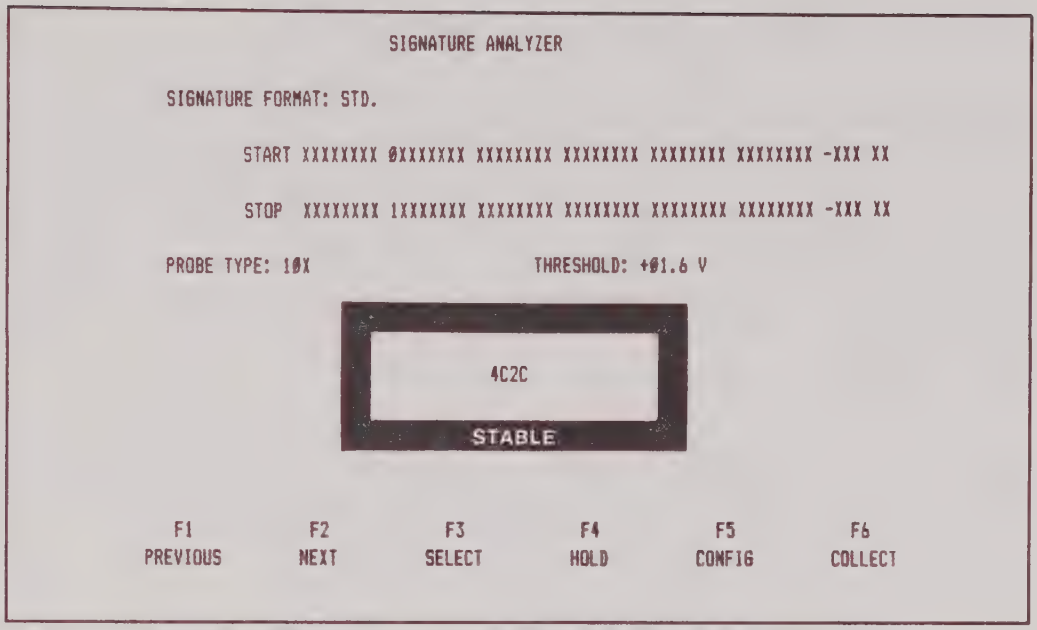

Figure 3-58. Display of Signature for Test Point DB0 of the B Channel
(Your signature may differ because there are several versions of the test card in the field)

3.9.30 Fault-Isolation

Using REPEAT mode, generate a fault. With probe on DB0 on B channel side of the test card, place shorting wire on pin 2 of U3. U3 is located at top center of test card. This fault changes the counting sequence of the B counter. Press COLLECT to obtain a new signature for test point DB0. The new signature, shown in Figure 3-59, differs from signature in Figure 3-58.

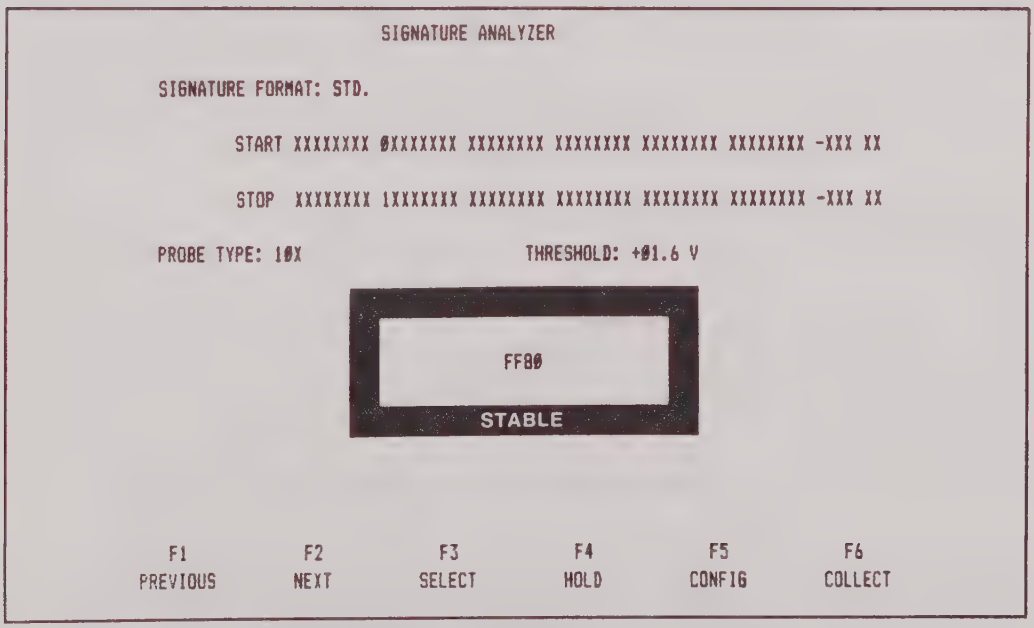

Figure 3-59. New Signature For DB0 (B Counter)

3.9.31 Advanced Signature Analysis (Example)

NPC-800D's signature analyzer provides additional capabilities that can be used to test complex state sequences. Often, digital systems do not contain separate on-board start and stop signals representing complex events. NPC-800D's 53-bit-wide word recognition circuitry can be used to supply necessary signals (in the previous basic example, a single bit was used for both start and stop signals). For advanced applications, the entire 53-bit-wide trigger word, consisting of 48 data bits and 3 qualifiers from the data probes plus the E and L bits, can be used to control the signature analyzer. E bit provides a single bit qualification for independent synchronization from a signal anywhere in the circuitry that's being tested. L bit provides a powerful linkage capability to one or more additional logic analyzers.

3.9.32 Software Signatures

As a practical example, the beginning and ending addresses of a software routine could be used to gate the signature analyzer. By placing the Model 90 probe on the LSB of the address word during program execution, a unique signature of executing code is obtained. In this manner, faulty software or "unannounced" revisions can be rapidly uncovered.

3.10 ANALOG WAVEFORM RECORDER

The Analog Waveform Recorder option provides the user with an easy-to-use instrument very similar to a digital oscilloscope. The menu allows you to set up the same parameters that you would on an oscilloscope, except that you do it from the keyboard rather than using knobs. It samples analog signals, using a standard oscilloscope-type probe, at speeds up to 50 MHz. At each clock sample, the analog data undergoes a analog-to-digital conversion, with 6 bits of accuracy. The reconstructed analog data can then be displayed on the CRT as a waveform, or it can be used to trigger the logic analyzer.

3.10.1 Basic Waveform Analysis (Optional Waveform Analyzer Must Be Installed)*

To demonstrate basic waveform recording features of the NPC-800D, the user need only set desired sample period, the vertical axis attenuation factor (dependent on input signal levels), connect scope probe to waveform test point on test card, and press COLLECT. After data collection, captured waveform may be magnified, measured, and stored in a manner similar to timing diagram display discussed previously. In addition, voltage information is displayed.

3.10.2 Waveform Menu (1000 Words, 50 MHz)

3.10.3 To Call Up Menu

1. Press CONFIG or RESET key.
2. Press SEL DOWN or SEL UP to select WAVEFORM RECORDER mode.
3. Press WAVEFORM (F1) key to call menu.

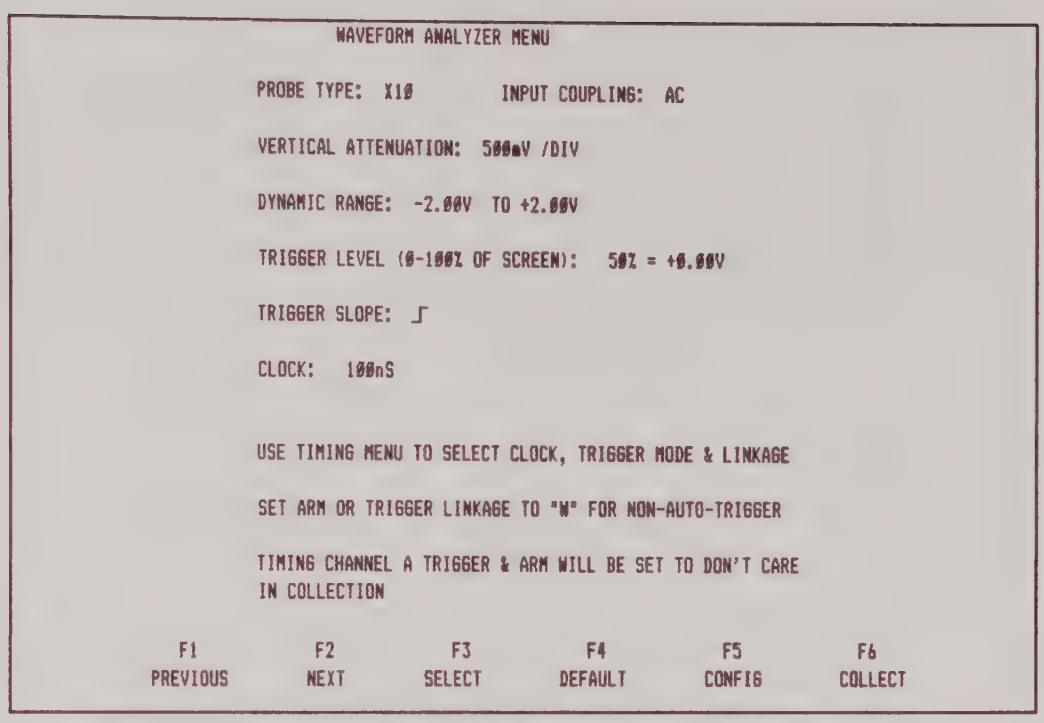
WAVEFORM ANALYZER MENU
PROBE TYPE: X10
INPUT COUPLING: AC
VERTICAL ATTENUATION: 500mV /DIV
DYNAMIC RANGE: -2.00V TO +2.00V
TRIGGER LEVEL (0-100% OF SCREEN): 50% = +0.00V
TRIGGER SLOPE:
CLOCK: 100nS
USE TIMING MENU TO SELECT CLOCK, TRIGGER MODE & LINKAGE
SET ARM OR TRIGGER LINKAGE TO "W" FOR NON-AUTO-TRIGGER
TIMING CHANNEL A TRIGGER & ARM WILL BE SET TO DON'T CARE IN COLLECTION
F1 PREVIOUS
F2 NEXT
F3 SELECT
F4 DEFAULT
F5 CONFIG
F6 COLLECT

Figure 3-60. Waveform Menu

* If Waveform option is not installed, a baseline in the waveform display is not present when COLLECT key is pressed.

3.10.4 Explanation of Menu

Line 1: PROBE TYPE (X10,X1). This field configures the waveform analyzer for the type of probe used: INPUT COUPLING, DC, AC, GND. A match with the probe setting is required.

Line 2: ATTENUATOR. 5mV/DIV to 20V/DIV (X1 probe); 50mV/DIV to 200V/DIV (X10 probe).

Line 3: DYNAMIC RANGE. Select lower value to position voltage window. Input waveforms within this range are digitized, without saturation, by a/d converter.

Line 4: TRIGGER LEVEL. Threshold level for incoming waveform that causes analyzer to trigger.

Line 5: TRIGGER SLOPE. Rising or falling. This is the waveform slope at the threshold crossing required for triggering.

Line 6: Sampling rate value. This parameter is set in timing menu.

Lines 7-9: Instructions to use timing menu to set up sample clock rate. Trigger mode (including pretrigger), and linkage. For threshold and slope parameters of the waveform menu to be active, a W must be set into linkage portion of ARM or TRIG field; otherwise, waveform analyzer operates in an Auto-Trigger (free-running)mode when COLLECT is pressed.

3.10.5 Waveform (Example)

Press CONFIG key and step down to mode labeled WAVEFORM RECORDER. Press WAVEFORM (F1) key to call waveform menu. Connect Model 90 scope probe to WAVEFORM BNC at rear of NPC-800D. Set probe switch to X10 position.

Waveform menu contains typical oscilloscope-type parameters. Since default values are not appropriate for this example, these values should be changed as shown in Figure 6-31. Use keys F3 and F4 to change parameters in waveform menu.

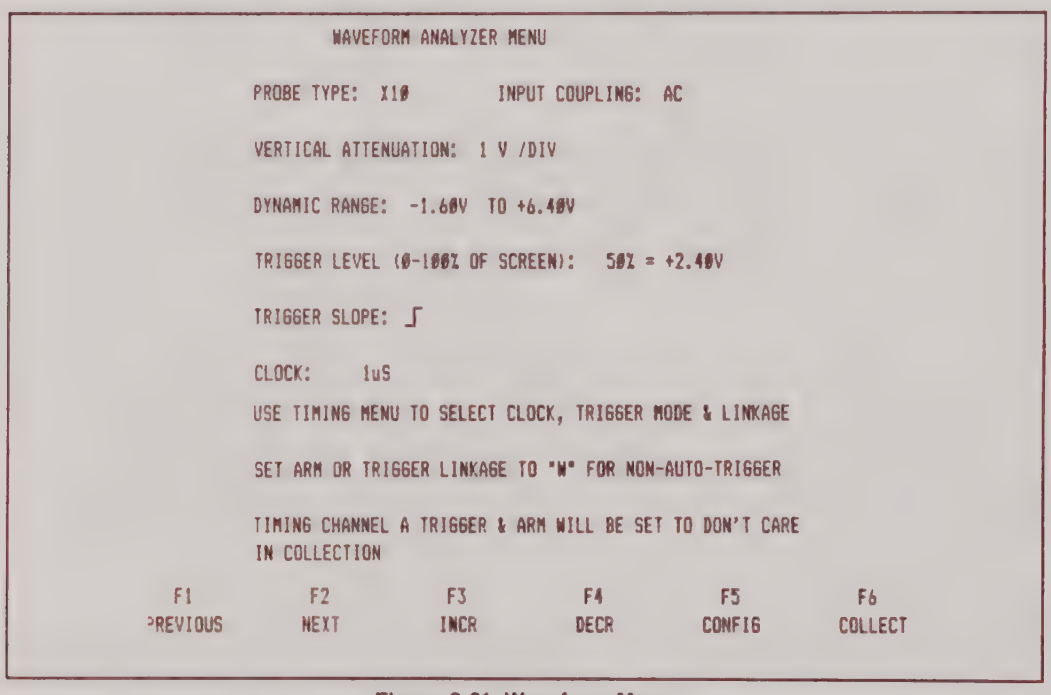
WAVEFORM ANALYZER MENU
PROBE TYPE: X10
INPUT COUPLING: AC
VERTICAL ATTENUATION: 1 V /DIV
DYNAMIC RANGE: -1.60V TO +6.40V
TRIGGER LEVEL (0-100% OF SCREEN): 50% = +2.40V
TRIGGER SLOPE:
CLOCK: 1uS
USE TIMING MENU TO SELECT CLOCK, TRIGGER MODE & LINKAGE
SET ARM OR TRIGGER LINKAGE TO "W" FOR NON-AUTO-TRIGGER
TIMING CHANNEL A TRIGGER & ARM WILL BE SET TO DON'T CARE IN COLLECTION
F1 PREVIOUS
F2 NEXT
F3 INCR
F4 DECR
F5 CONFIG
F6 COLLECT

Figure 3-61. Waveform Menu

3.10.6 Clock

Press S2 key followed by C key to automatically call up timing menu and activate clock field. Now press SLOWER or FASTER key and set clock to one microsecond.

3.10.7 Collect

Hold probe tip at junction of resistor and capacitor on A side of test card (test point labeled WF) and press COLLECT. Remove probe.

NOTE

A baseline in waveform display is not present if COLLECT key is pressed when this option is not installed.

To view entire 1000-sample data collection, with X1 magnification selected, waveform should be as shown in Figure 3-62. Use other magnification keys and WINDOW and CURSOR keys to examine collected data in detail and to make timing and voltage measurements. Return to a 1X magnification.

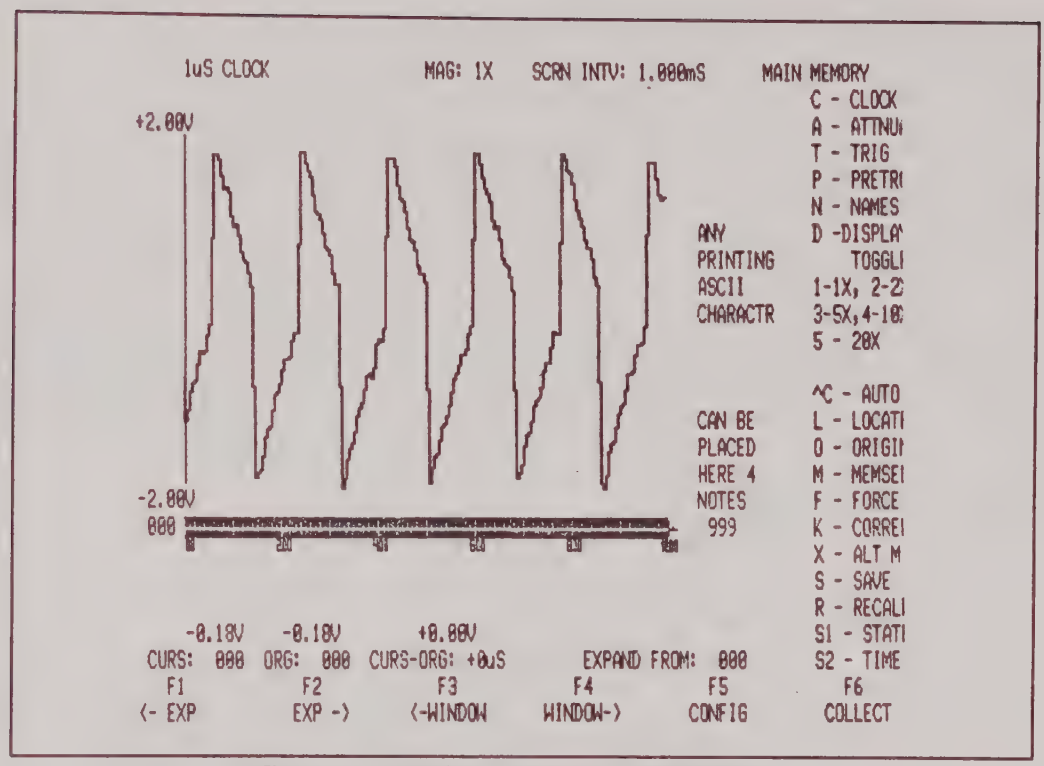

Figure 3-62. Waveform Display at 1X Magnification

3.10.8 Waveform Display (1000 Words, 50 MHz)

3.10.9 Explanation of Waveform Display

Press D key once for unconnected, software interpreted values. Press D key a second time for raw sample points. Press D key a third time to return to a software-smoothed display.

Line 1: Displays internal (or external) clock sampling interval, magnification factor, screen interval, and MAIN/AUX memory.

Line 3: Displays most positive voltage of measurement window at left.

Line 17: Displays most negative voltage of measurement window at left.

Line 18: Displays inverse video graticule which shows range and position (relative to entire 1000-sample data collection) of current display. Trigger point is intensified.

Line 22: Displays voltage at cursor, voltage at origin, and voltage difference between cursor and origin (measurement accuracy is plus or minus approximately three percent).

Line 23: Displays current location of cursor, current location of origin, difference in time between cursor and origin values (for time measurement), and expansion reference location.

NOTE

Expansion symbol, E, used in timing display, is not available in waveform display. However, EXPAND FROM: indicator is still valid.

Lines 2-23: Direct entry and display manipulation keys.

Lines 24 and 25: Soft-key identifiers and labels.

Lines 7-17: Text which can be entered by the user to describe collected data. Use N key, as with timing diagram labeling. Any alphanumeric or ASCII character is permitted in this area, maximum of 8 per line.

3.10.10 Auto-Trigger

In above example, waveform analyzer was in Auto-Trigger mode. That is, the one microsecond clock begins sampling the analog signal as soon as COLLECT key is pressed, without regard to trigger level and signal slope. This free-running mode can be inhibited by setting ARM or TRIGGER linkage field, in timing menu, to W. In this manner, only incoming analog signals that meet the triggering conditions of the waveform menu are collected.

3.10.11 Advanced Waveform (Examples, Optional Waveform Board Must Be Installed)*

* A baseline in the waveform display is not present if COLLECT key is pressed when Waveform option is not installed.

In this section, the optional waveform analyzer is used to monitor the composite video signal coming from the video BNC connector of the NPC-800D. In addition, to illustrate the "single-shot" storage capability of the waveform analyzer, the LINKAGE field in the timing menu is set to W.

3.10.12 Waveform Mode

Press RESET and select WAVEFORM RECORDER mode when CONFIGURATION LIST appears.

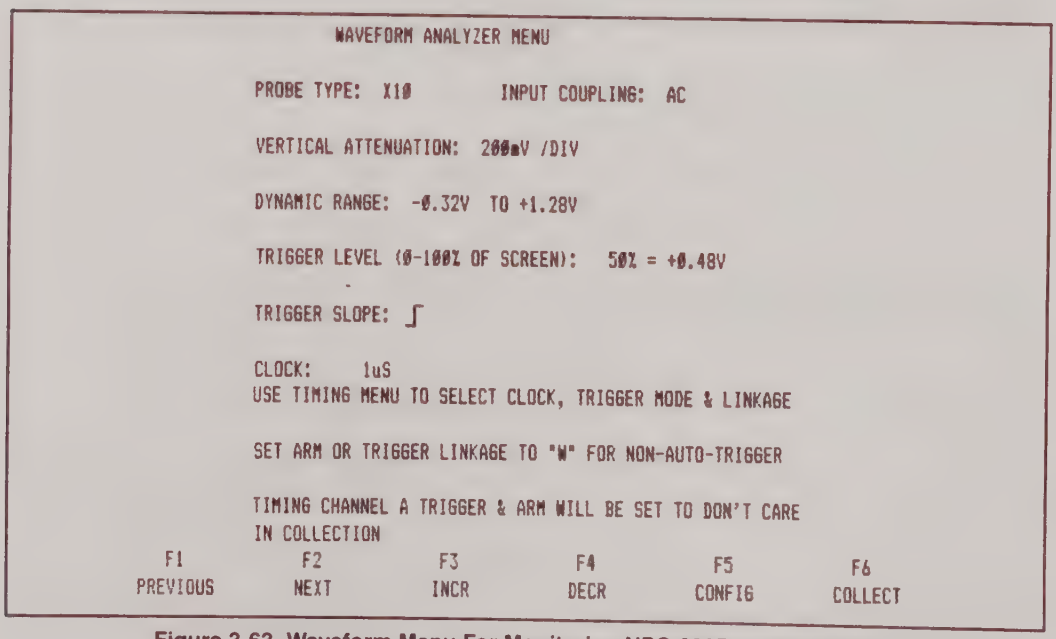
WAVEFORM ANALYZER MENU
PROBE TYPE: X1Ø
INPUT COUPLING: AC
VERTICAL ATTENUATION: 2ØØmV /DIV
DYNAMIC RANGE: -Ø.32V TO +1.28V
TRIGGER LEVEL (Ø-1ØØ% OF SCREEN): 5Ø% = +Ø.48V
TRIGGER SLOPE:
CLOCK: 1uS
USE TIMING MENU TO SELECT CLOCK, TRIGGER MODE & LINKAGE
SET ARM OR TRIGGER LINKAGE TO "W" FOR NON-AUTO-TRIGGER
TIMING CHANNEL A TRIGGER & ARM WILL BE SET TO DON'T CARE IN COLLECTION
F1 PREVIOUS
F2 NEXT
F3 INCR
F4 DECR
F5 CONFIG
F6 COLLECT

Figure 3-63. Waveform Menu For Monitoring NPC-800D's Video Signal

3.10.13 CLOCK (100 Nanoseconds)

Press S2 key followed by C key to call timing menu with cursor at clock field. Use a 100-nanosecond sample clock.

3.10.14 Single-Shot Mode (W)

Use NEXT key to step to TRIG LINKAGE field. Then use the SELECT key to enter a W into this field. Use NEXT key again to step down to PRETRIGGER field. Press the F3 or F4 key to increment or decrement the pretrigger value of 00 percent (see Figure 3-64).

```
                    16 CHNL TIMING/STATE  MENU

              1uS CLOCK
 TRIGGER WHEN:
              TRIG OCCURS >= 0000 CLOCKS AFTER FIRST ARM
             CHNL NO. A76543210 B76543210  EDGEQ  FILTER  LINKAGE
ARM (0,1,X):          XXXXXXXX  XXXXXXXX   X      OFF     NONE
TRIG (0,1,X):         XXXXXXXX  XXXXXXXX           OFF     W
PRE-TRIGGER:  00%

                      AAAAAAAA  BBBBBBBB
DISPLAY ORDER (0-7,X): 76543210  76543210
DISPLAY POLARITY (+,-): ++++++++ ++++++++
                              A PROBE            B PROBE
      THRESHOLD:      CH 0-3  CH 4-7  CLK, Q    CH 0-3  CH 4-7
  (-6.4V TO +6.35V)    +1.60   +1.60   +1.60      +1.60   +1.60
   INPUT MODE (S,L):   SAMPL   SAMPL             SAMPL   SAMPL



                                                          WAVEFORM
   S1 - STATE DISPLAY                                       LINK
   S2 - TIMING DISPLAY                                    EXT  INP
  F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT       SELECT      DEFAULT     CONFIG     COLLECT
```

Figure 3-64. Timing Menu Setup for Waveform (Example)

3.10.15 No Input Signal

In the NPC-800D, the timing menu is used to set up the waveform sample period and linkage. Setting a W into the LINKAGE field means that all triggering conditions associated with waveform menu (such as threshold and slope) must be satisfied by the incoming analog signal to be able to trigger the analyzer. Make certain that the Model 90 probe is set to X10. Plug it into rear BNC connector labeled WAVEFORM. With ground clip attached to body of any rear BNC connector, and Model 90 probe tip unconnected, press COLLECT. The waveform display is blank and status message ARMED flashes on CRT. This means that the W (or linkage) conditions are not being satisfied, so the waveform analyzer is inhibited from triggering.

3.10.16 Video Input

Insert probe tip into rear BNC connector labeled VIDEO. Then press COLLECT key to get a "clean" data collection. At 1X magnification, display should look approximately as shown in Figure 3-65. The negative-going pulse after the video pulse group is the horizontal sync pulse.

NOTE

Since video signal levels can vary from unit-to-unit, you may have to adjust waveform menu settings slightly to match Figure 3-65.)

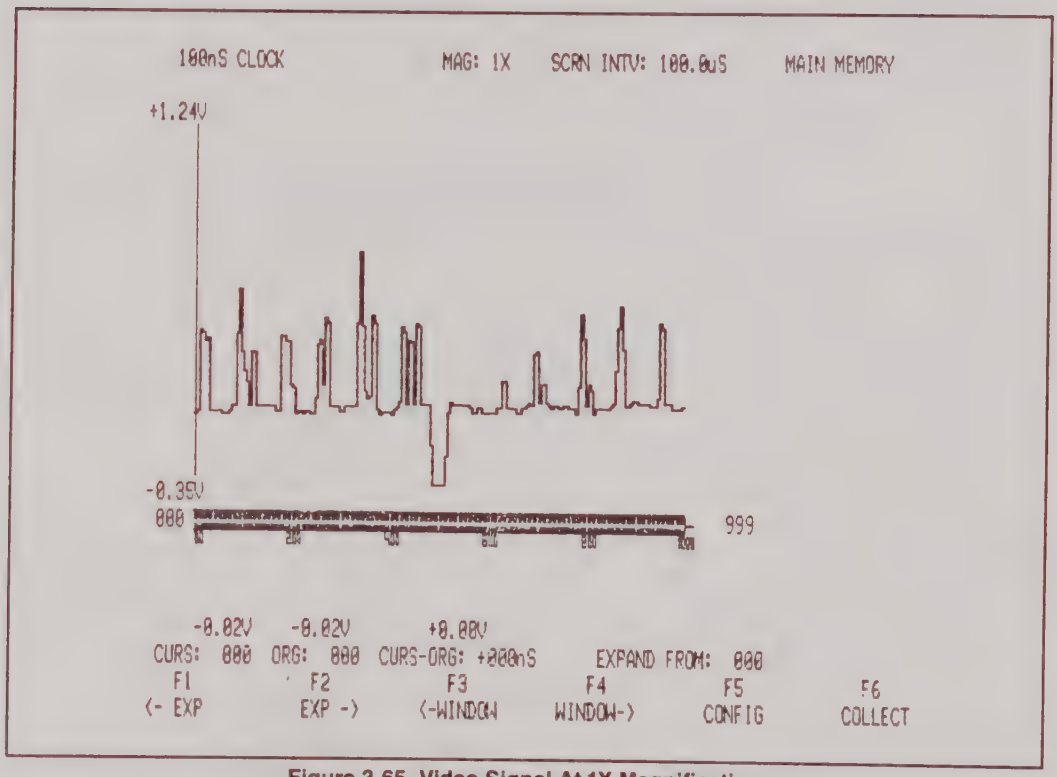

Figure 3-65. Video Signal At 1X Magnification

3.10.17 Expand

Press X2 (2), X5 (3), X10 (4), X20 (5) keys to view video signal at different magnification factors. Return to X1 magnification and press EXPAND key until EXPAND FROM indicator at lower-right corner of CRT corresponds to approximate position in memory of sync pulse (no E symbol is used in the waveform display). Then press X10 (4) key. Next press WINDOW or keys as required to center sync pulse (see Figure 3-66).

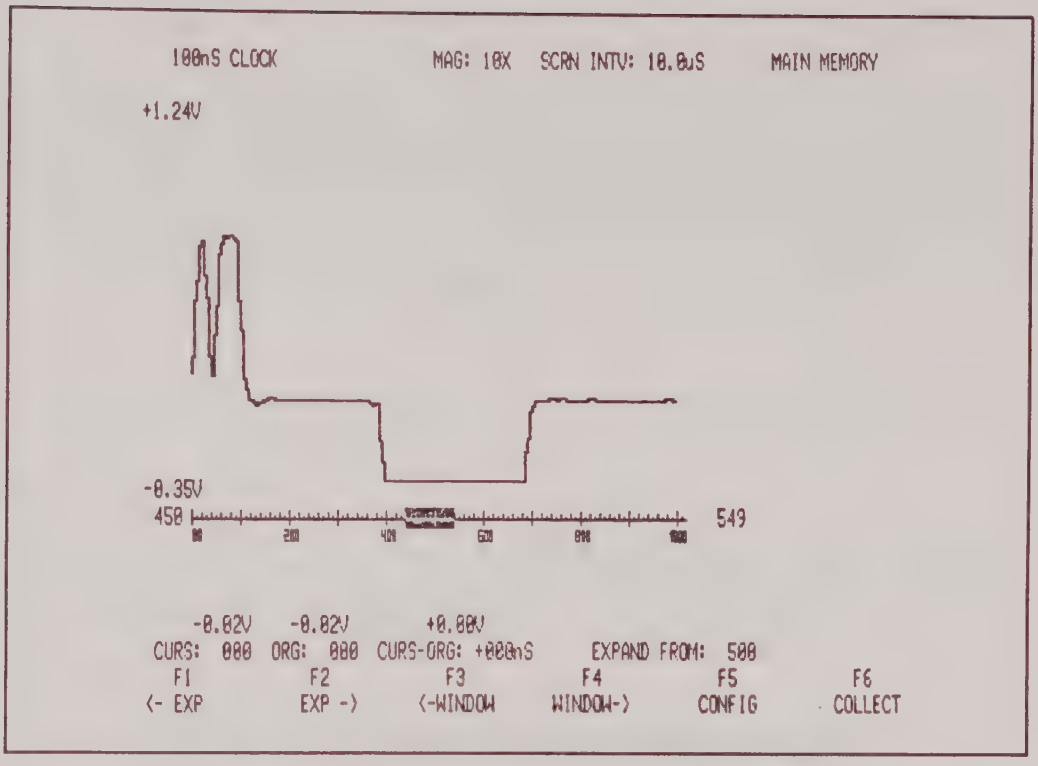

Figure 3-66. Examining Sync Pulse At X10 Magnification

Return to 1X magnification and use EXPAND key to return EXPAND FROM indicator to 000. Then press X20 key to again view any video pulse group at X20 magnification.

3.10.18 Waveform Display Magnification Concepts

X1 - For this magnification factor, each point of the waveform display represents five samples of data in the timing memory. Software takes the first valid sample (i.e., the fourth sample), then scans subsequent sets of five samples each, choosing samples with largest deviation from last point displayed. This procedure continues until 997 samples in memory are processed.

X2 - For X2 magnification, the display process is similar to X1 magnification, except that only 500 samples of timing memory are scanned in alternating groups of two and three samples.

X5 - Here, 200 samples of the timing memory are used to display 200 waveform points on the screen. A filtering algorithm is used to smooth data at X5 and higher magnifications.

X10 - Here, 100 samples of timing memory are used to generate 200 waveform points on the display. Interpolated points are calculated by a linear interpolation algorithm. Furthermore, the filtering algorithm mentioned previously is also used.

X20 - Here, 50 samples of timing memory are used to generate 200 points of waveform data. Each timing sample stored in memory generates four points on the display. A linear interpolation method is used for the interpolated points; then it is smoothed by the filtering algorithm.

3.10.19 Save (S)

Press SAVE (S) key to store waveform and menu in the auxiliary memory. Then press COMPARE (X) key to compare main and auxiliary memories. Return to main memory by pressing MEMSEL (M) key as required. Next press COLLECT to take another data collection. Use X key to compare new collection with reference collection (there should be differences in both amplitude and time). Figure 3-67 shows screens for Main and Aux memories (notice difference in waveforms). Your example will probably differ.

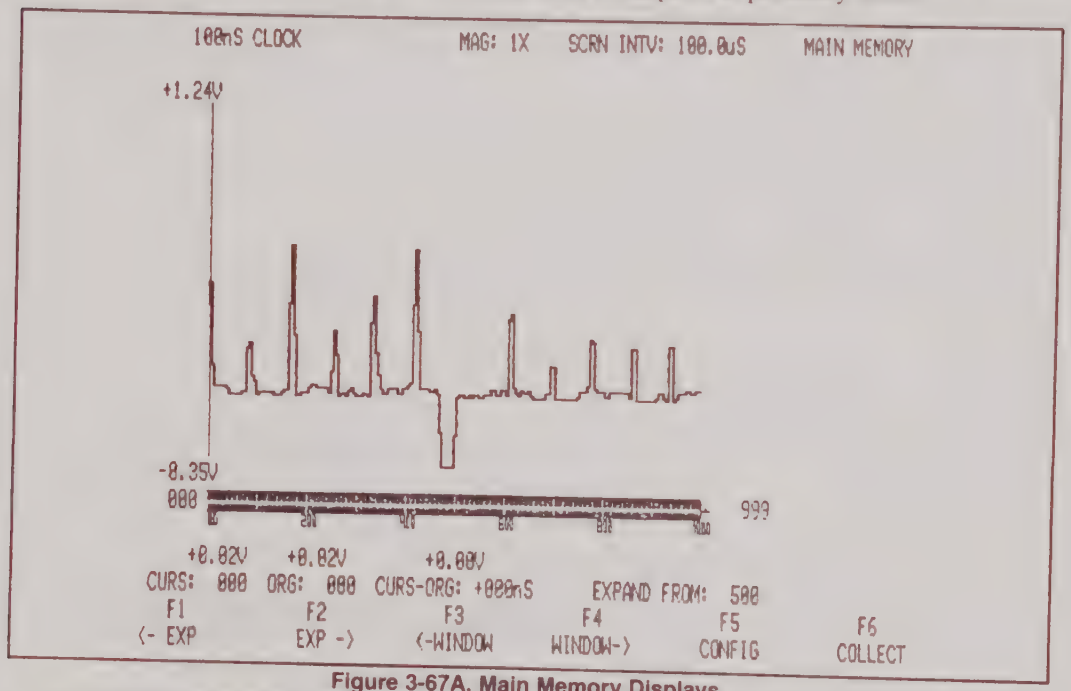

Figure 3-67A. Main Memory Displays

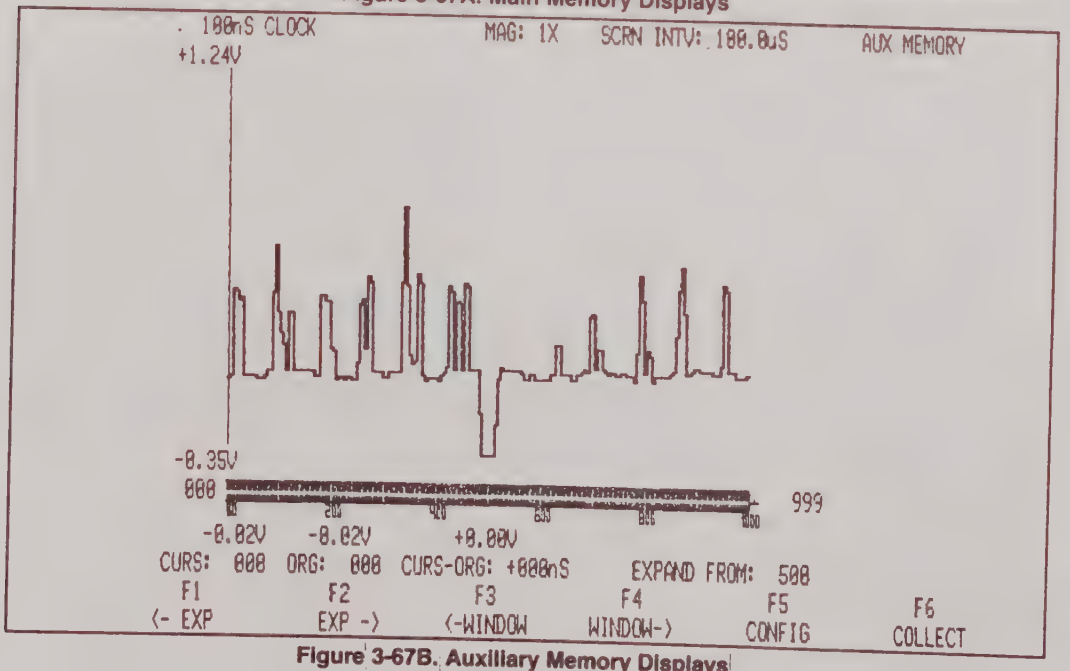

Figure 3-67B. Auxiliary Memory Displays

3.10.20 Correlation (K)

Press SAVE (S) key and observe flashing SAVED message. Press K (CORREL) key to compare main and auxiliary data. A correlation factor of 1.000 is displayed at the right of each channel. This factor means that all 1000 bits associated with each main memory channel compares with the 1000 bits in the corresponding auxiliary memory channel on a bit-for-bit basis (see Figure 3-34). Thus, if a correlation factor for .995 were displayed, it would indicate that 5 samples out of 1000 were different on this bit. The 6bit A/D converter has its MSB nearest the top of the display. Bits 7 and 8 are always zero.

NOTE

When the K key is pressed, correlation factors replace NAMES. To restore NAMES, press S2.

3.10.21 Measurements

Locate cursor by pressing L key. Experiment with making voltage and time measurements in the main and auxiliary memories using the cursor. ORIGIN (O) key can be used here to relocate origin from 000 to any cursor location.

3.10.22 Aliasing

Because of an insufficient sample rate (below Nyquist limit), aliasing occurs when a high frequency waveform appears on the display as a low frequency waveform.

To avoid aliasing, as a conservative rule of thumb, always sample at 5 to 10 times faster than highest frequency component of incoming waveform.

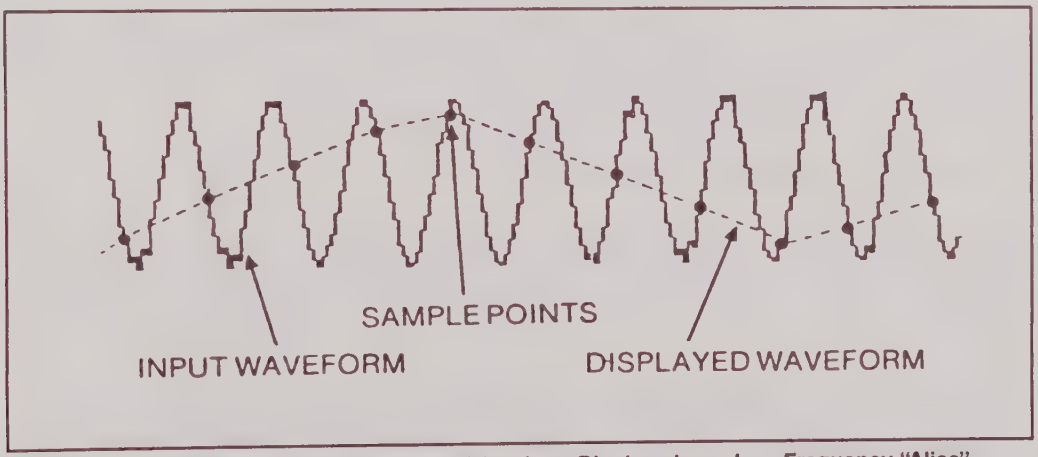

Figure 3-68. Aliasing High Frequency Waveform Displayed as a Low Frequency "Alias"

3.10.23 State Version Of Waveform Display

3.10.24 To Call Display

1. Press COLLECT key to perform data collection.
2. Or if data have been collected, press S1 key.
3. Press BIN (N) key.

```
MAIN        +007  00011110 11101000
            +008  00011110 11101000
LOC: +007   +009  00011101 11101000
            +010  00011111 11101000
SIG: AC5B   +011  00111001 11101000
     943F   +012  00111110 11101000
            +013  00111100 11101000
            +014  00110100 11101000
            +015  00011100 11101000
            +016  00011111 11101000
            +017  00011101 11101000
            +018  00011101 11101000
            +019  00011101 11101000
            +020  00011101 11101000
            +021  00011101 11101000
            +022  00011101 11101000
            +023  00111000 11101000
            +024  00111110 11101000
            +025  00111100 11101000
            +026  00100000 11101000
            +027  00011101 11101000
            +028  00011111 11101000
            +029  00011110 11101000
```

Figure 3-69. Binary Values of Waveform Samples

3.10.25 Explanation of State Version of Waveform Display

The state version of the waveform display is similar to the 16-channel state display. However, for the waveform analyzer, binary words represent instantaneous voltage values at sample points of incoming analog signal (since waveform analyzer uses a 6-bit a/d converter, the two MSB's in the 8-bit display are always 0).

3.11 WAVEFORM AND STATE ANALYSIS

This section demonstrates simultaneous use of the analog waveform recorder and the state analyzer. There are two ways to use both features. First, while collecting both state and waveform information, the waveform recorder can trigger the state analyzer. Second, while collecting both state and waveform information, the state analyzer can enable the waveform recorder.

To demonstrate the waveform recorder triggering the state analyzer, press RESET, which initializes the instrument. Then select (from the Configuration list) State/Waveform mode. Set up waveform menu as in Figure 3-70. The "1" set into the last trigger bit of the state analyzer causes the state analyzer to wait for the occurrence of the waveform trigger conditions before it continues through the state trigger sequence (timing and state menus are shown in Figure 3-71 and 3-72).

```
                    WAVEFORM ANALYZER MENU

          PROBE TYPE:  X1Ø          INPUT COUPLING:  AC

          VERTICAL ATTENUATION:  1 V /DIV

          DYNAMIC RANGE:  -Ø.56V  TO +7.44V

          TRIGGER LEVEL (Ø-1ØØ% OF SCREEN):   5Ø% = +3.44V

          TRIGGER SLOPE:  ┌

          CLOCK:     1uS


          USE TIMING MENU TO SELECT CLOCK, TRIGGER MODE & LINKAGE

          SET ARM OR TRIGGER LINKAGE TO "W" FOR NON-AUTO-TRIGGER

          TIMING CHANNEL A TRIGGER & ARM WILL BE SET TO DON'T CARE
          IN COLLECTION


   F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT        INCR        DECR        CONFIG      COLLECT
```

Figure 3-70. Waveform Menu

```
                  16 CHNL TIMING/STATE  MENU

            1ØØnS CLOCK
 TRIGGER WHEN:
              TRIG OCCURS >= ØØØØ CLOCKS AFTER FIRST ARM
             CHNL NO. A76543210 B76543210  EDGEQ  FILTER  LINKAGE
ARM (Ø,1,X):          XXXXXXXX  XXXXXXXX   X      OFF     NONE
TRIG (Ø,1,X):         XXXXXXXX  XXXXXXXX           OFF     W
PRE-TRIGGER:   ØØ%

                      AAAAAAAA  BBBBBBBB
DISPLAY ORDER (Ø-7,X): 76543210  76543210
DISPLAY POLARITY (+,-): ++++++++  ++++++++
                           A PROBE             B PROBE
      THRESHOLD:      CH Ø-3  CH 4-7  CLK, Q    CH Ø-3  CH 4-7
  (-6.4V TO +6.35V)    +1.6Ø   +1.6Ø   +1.6Ø     +1.6Ø   +1.6Ø
  INPUT MODE (S,L):    SAMPL   SAMPL             SAMPL   SAMPL




   S1 - STATE DISPLAY                                          P -EXT P
   S2 - TIMING DISPLAY                                         N -EXT N
  F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT        SLOWER      FASTER      CONFIG      COLLECT
```

Figure 3-71. Timing Menu

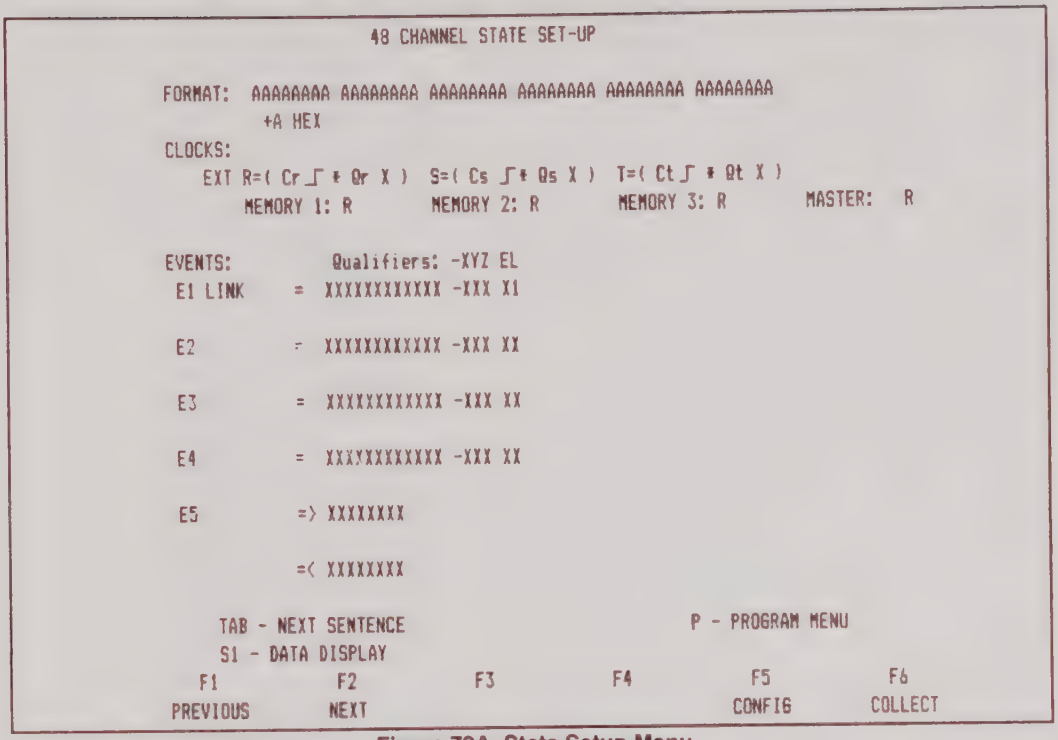
48 CHANNEL STATE SET-UP
FORMAT: AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA
+A HEX
CLOCKS:
EXT R=(Cr ⌐ ⌐ Qr X) S=(Cs ⌐ ⌐ Qs X) T=(Ct ⌐ ⌐ Qt X)
MEMORY 1: R MEMORY 2: R MEMORY 3: R MASTER: R
EVENTS: Qualifiers: -XYZ EL
E1 LINK = XXXXXXXXXXXX -XXX X1
E2 = XXXXXXXXXXXX -XXX XX
E3 = XXXXXXXXXXXX -XXX XX
E4 = XXXXXXXXXXXX -XXX XX
E5 => XXXXXXXX
=< XXXXXXXX
TAB - NEXT SENTENCE
P - PROGRAM MENU
S1 - DATA DISPLAY
F1 PREVIOUS
F2 NEXT
F3
F4
F5 CONFIG
F6 COLLECT

Figure 72A. State Setup Menu

Attach test card to state probes A & B. Then attach the Model 90 probe to the waveform input on back panel of NPC-800D. Press COLLECT.

The state analyzer progresses through its trigger stack in sequence, until reaching step 2, where it waits for the "link" from the waveform recorder. To allow the waveform recorder to recognize its trigger conditions, insert tip of waveform probe into "VIDEO" output BNC on back panel. The analog signal source for triggering is accessed. Once the waveform recorder has triggered, it enables the state analyzer to continue through its trigger sequence and complete data collection (see Figures 3-73 and 3-74).

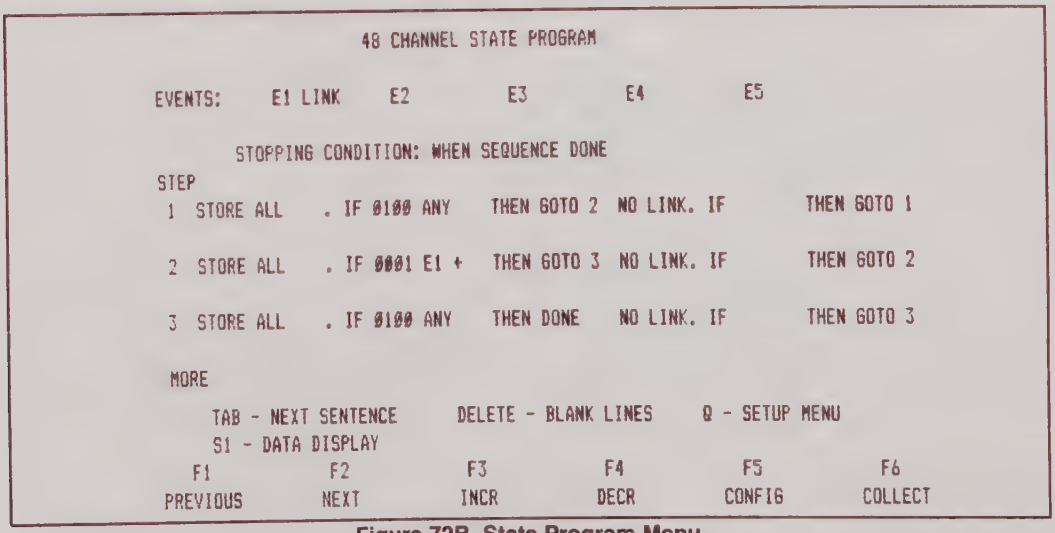
48 CHANNEL STATE PROGRAM
EVENTS: E1 LINK E2 E3 E4 E5
STOPPING CONDITION: WHEN SEQUENCE DONE
STEP
1 STORE ALL . IF 0100 ANY THEN GOTO 2 NO LINK. IF THEN GOTO 1
2 STORE ALL . IF 0001 E1 + THEN GOTO 3 NO LINK. IF THEN GOTO 2
3 STORE ALL . IF 0100 ANY THEN DONE NO LINK. IF THEN GOTO 3
MORE
TAB - NEXT SENTENCE
DELETE - BLANK LINES
Q - SETUP MENU
S1 - DATA DISPLAY
F1 PREVIOUS
F2 NEXT
F3 INCR
F4 DECR
F5 CONFIG
F6 COLLECT

Figure 72B. State Program Menu

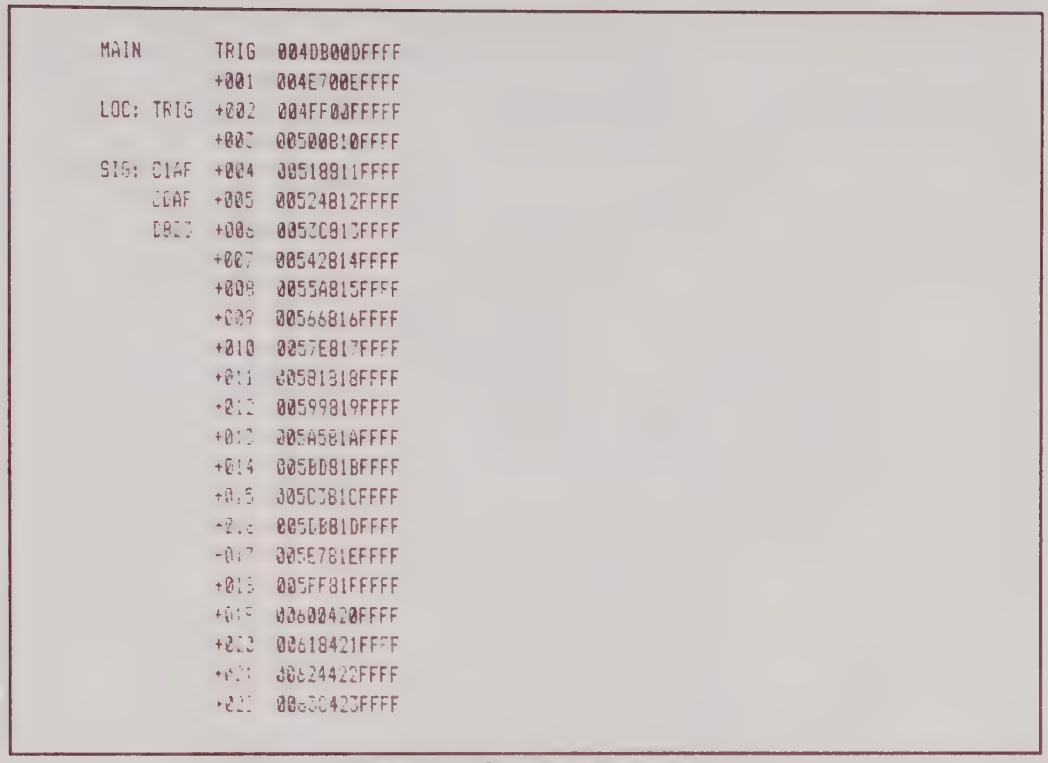

Figure 3-73. State Data Collection

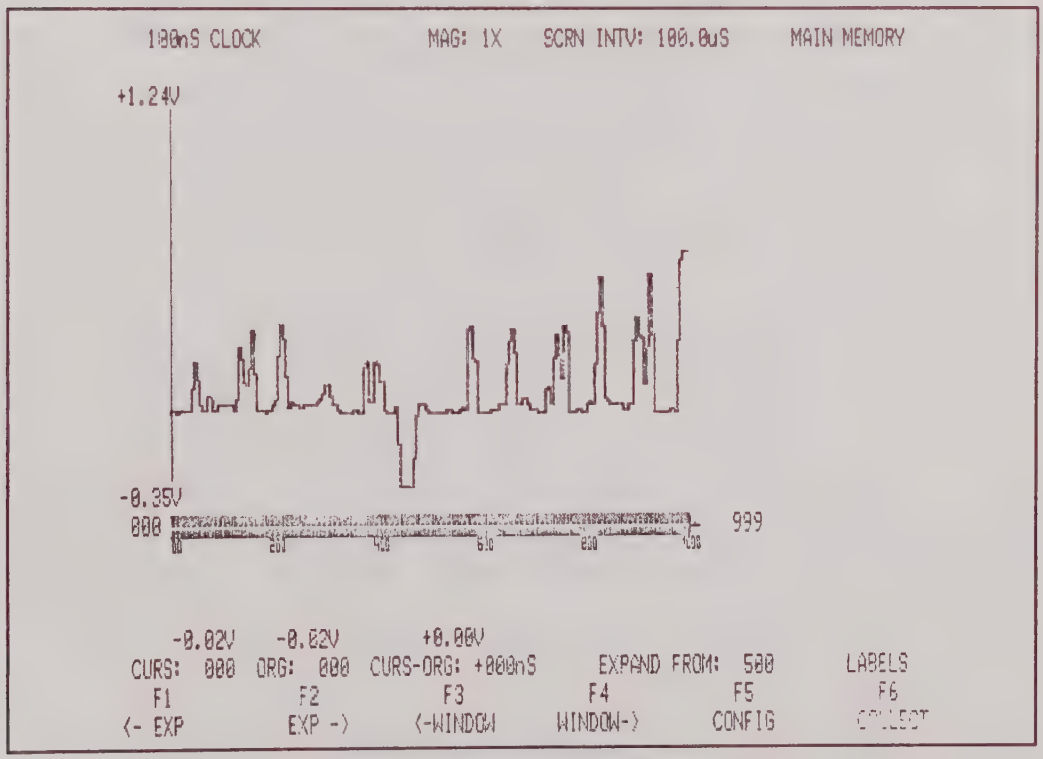

Figure 3-74. Waveform Data Collection

To use the state analyzer to enable the waveform recorder, change state program menu to that shown in Figure 3-75, and Timing menu to that shown in Figure 3-76. To allow waveform recorder to recognize its trigger conditions, again insert tip of waveform probe into "VIDEO" output BNC on back panel. To inhibit trigger word specified in trigger step 2, short out data bit 0 on A side of test card. Press COLLECT.

```
                    48 CHANNEL STATE SET-UP

FORMAT:  AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA
         +A HEX
CLOCKS:
   EXT R=( Cr ⌐ + Qr X )  S=( Cs ⌐ + Qs X )  T=( Ct ⌐ + Qt X )
       MEMORY 1: R        MEMORY 2: R        MEMORY 3: R        MASTER:   R

EVENTS:          Qualifiers: -XYZ EL
 E1 ZERO     =  0000XXXXXXXX -XXX XX

 E2 FIVE     =  0005XXXXXXXX -XXX XX

 E3 NUMBER   =  0048XXXXXXXX -XXX XX

 E4          =  XXXXXXXXXXXX -XXX XX

 E5          => XXXXXXXX

             =( XXXXXXXX

    TAB - NEXT SENTENCE                          P - PROGRAM MENU
    S1 - DATA DISPLAY
  F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT                                CONFIG      COLLECT
```

Figure 3-75A. State Setup Menu

```
                    48 CHANNEL STATE PROGRAM

EVENTS:    E1 ZERO    E2 FIVE    E3 NUMBER  E4         E5

       STOPPING CONDITION: WHEN SEQUENCE DONE
STEP
 1  STORE NONE   . IF 0001 E1 +   THEN GOTO 2  NO LINK. IF       THEN GOTO 1

 2  STORE NONE   . IF 5000 ANY    THEN GOTO 3  NO LINK. IF       THEN GOTO 1

 3  STORE ALL    . IF 0001 E2 +   THEN GOTO 4 AND LINK. IF      THEN GOTO 1

 4  STORE ALL    . IF 0200 ANY    THEN DONE    NO LINK. IF       THEN GOTO 1

 MORE


   TAB - NEXT SENTENCE      DELETE - BLANK LINES     Q - SETUP MENU
   S1 - DATA DISPLAY
  F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT        SELECT      DEFAULT     CONFIG      COLLECT
```

Figure 3-75B. State Program Menu

```
                    16 CHNL TIMING/STATE  MENU

            100nS CLOCK
 TRIGGER WHEN:
              TRIG OCCURS >= 0000 CLOCKS AFTER FIRST ARM
             CHNL NO. A76543210 B76543210  EDGE0  FILTER  LINKAGE
ARM (0,1,X):          XXXXXXXX  XXXXXXXX    X      OFF     L
TRIG (0,1,X):         XXXXXXXX  XXXXXXXX           OFF     NONE
PRE-TRIGGER:  20%

                      AAAAAAAA  BBBBBBBB
DISPLAY ORDER (0-7,X): 76543210  76543210
DISPLAY POLARITY (+,-): ++++++++  ++++++++
                              A PROBE              B PROBE
      THRESHOLD:      CH 0-3  CH 4-7  CLK, Q    CH 0-3  CH 4-7
  (-6.4V TO +6.35V)    +1.60   +1.60   +1.60      +1.60   +1.60
  INPUT MODE (S,L):    SAMPL   SAMPL             SAMPL   SAMPL




   S1 - STATE DISPLAY
   S2 - TIMING DISPLAY
  F1         F2          F3          F4          F5          F6
PREVIOUS    NEXT        INCR        DECR        CONFIG      COLLECT
```

Figure 3-76. Timing Menu

The state analyzer progresses to step 2, where the trigger word has been inhibited. The waveform analyzer is still waiting for the state analyzer to set the internal LINK bit on step 3, even though we know it has "seen" its analog trigger condition many times. Remove short from data bit 0 (located on test card) to allow trigger word at step 2 to occur. Waveform recorder is enabled and recognizes that its trigger conditions have been met. It then finishes the data collection.

3.12 WAVEFORM AND TIMING ANALYSIS

Since the waveform recorder and timing analyzer use the same internal clock and the same memory boards, the NPC-800D CANNOT COLLECT BOTH TIMING AND WAVEFORM DATA SIMULTANEOUSLY (see Application Note entitled "Linking Resources in 800 Series Logic Analyzers"). The following example shows how to use the waveform recorder to trigger (or arm) the timing analyzer to collect timing data.

Press RESET, select TIMING mode, and set up timing menu (as in Figure 3-77) and waveform menu (as shown in Figure 3-78). These conditions cause the timing analyzer to arm on the occurrence of the specified ARM word. It waits for the waveform recorder to recognize its trigger conditions before completing its trigger sequence and the collection of data.

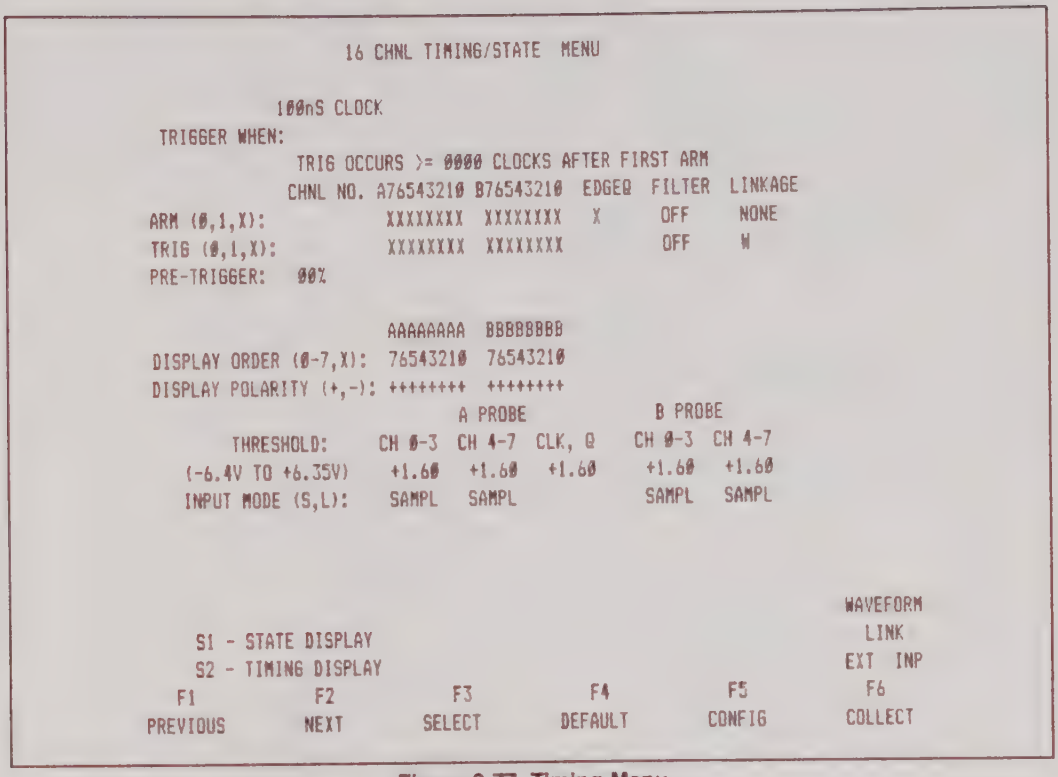
16 CHNL TIMING/STATE MENU
100nS CLOCK
TRIGGER WHEN:
TRIG OCCURS >= 0000 CLOCKS AFTER FIRST ARM
CHNL NO. A76543210 B76543210 EDGE@ FILTER LINKAGE
ARM (0,1,X): XXXXXXXX XXXXXXXX X OFF NONE
TRIG (0,1,X): XXXXXXXX XXXXXXXX OFF W
PRE-TRIGGER: 00%
AAAAAAAA BBBBBBBB
DISPLAY ORDER (0-7,X): 76543210 76543210
DISPLAY POLARITY (+,-): ++++++++ ++++++++
A PROBE B PROBE
THRESHOLD: CH 0-3 CH 4-7 CLK, @ CH 0-3 CH 4-7
(-6.4V TO +6.35V) +1.60 +1.60 +1.60 +1.60 +1.60
INPUT MODE (S,L): SAMPL SAMPL SAMPL SAMPL
WAVEFORM
LINK
EXT INP
S1 - STATE DISPLAY
S2 - TIMING DISPLAY
F1 F2 F3 F4 F5 F6
PREVIOUS NEXT SELECT DEFAULT CONFIG COLLECT

Figure 3-77. Timing Menu

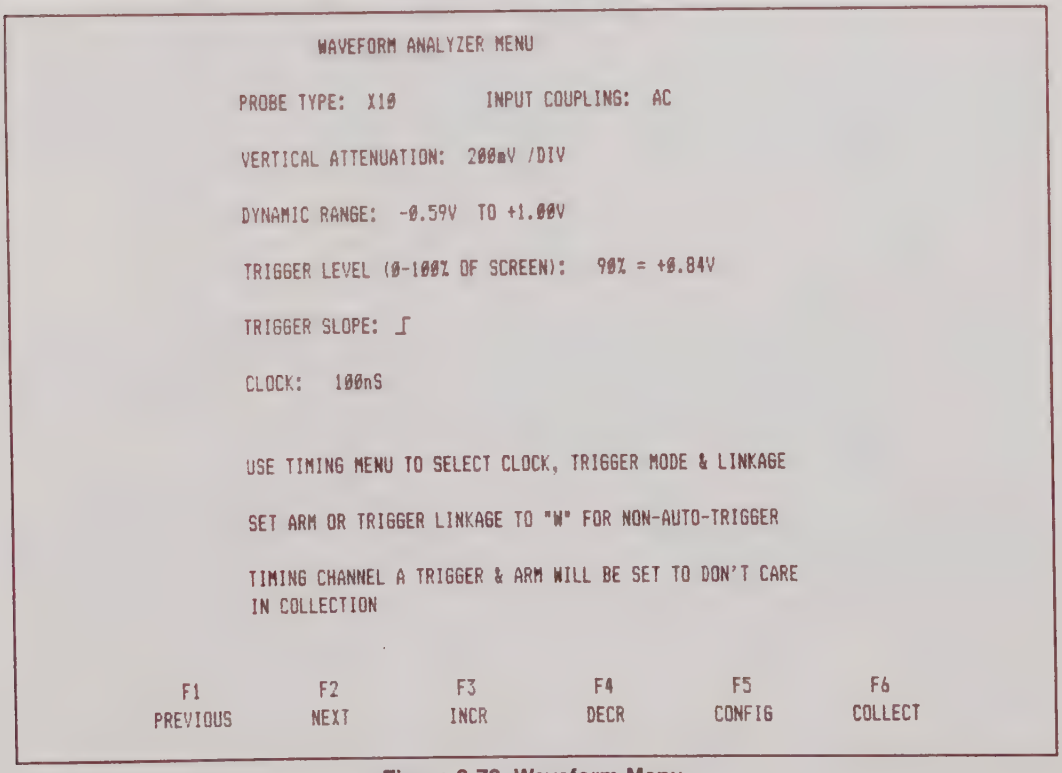
WAVEFORM ANALYZER MENU
PROBE TYPE: X10 INPUT COUPLING: AC
VERTICAL ATTENUATION: 200mV /DIV
DYNAMIC RANGE: -0.59V TO +1.00V
TRIGGER LEVEL (0-100% OF SCREEN): 90% = +0.84V
TRIGGER SLOPE: _|
CLOCK: 100nS
USE TIMING MENU TO SELECT CLOCK, TRIGGER MODE & LINKAGE
SET ARM OR TRIGGER LINKAGE TO "W" FOR NON-AUTO-TRIGGER
TIMING CHANNEL A TRIGGER & ARM WILL BE SET TO DON'T CARE
IN COLLECTION
F1 F2 F3 F4 F5 F6
PREVIOUS NEXT INCR DECR CONFIG COLLECT

Figure 3-78. Waveform Menu

Connect test card to timing probes and press COLLECT. Timing is now ARM'ed, waiting for waveform "link". Again, to allow waveform to trigger, insert waveform probe tip into "VIDEO" BNC on back panel. This allows timing analyzer to trigger and collect timing data.

3.13 WAVEFORM AND STATE AND TIMING ANALYSIS

The following example demonstrates the simultaneous use of the analog waveform recorder, the state analyzer, and the timing analyzer. It shows the waveform recorder arming the timing analyzer, the state analyzer enabling the timing trigger word to be recognized, and the collection of state and timing data.

Press RESET to initialize instrument. Select Waveform mode to set up waveform menu as shown in Figure 3-79. Then, to set up the state and timing menus, select STATE/TIMING mode as shown in Figures 3-80, and 3-81. Attach A state probe to A side of test card, and A timing probe to B side the test card. Short out data bit 0 on A side of test card.

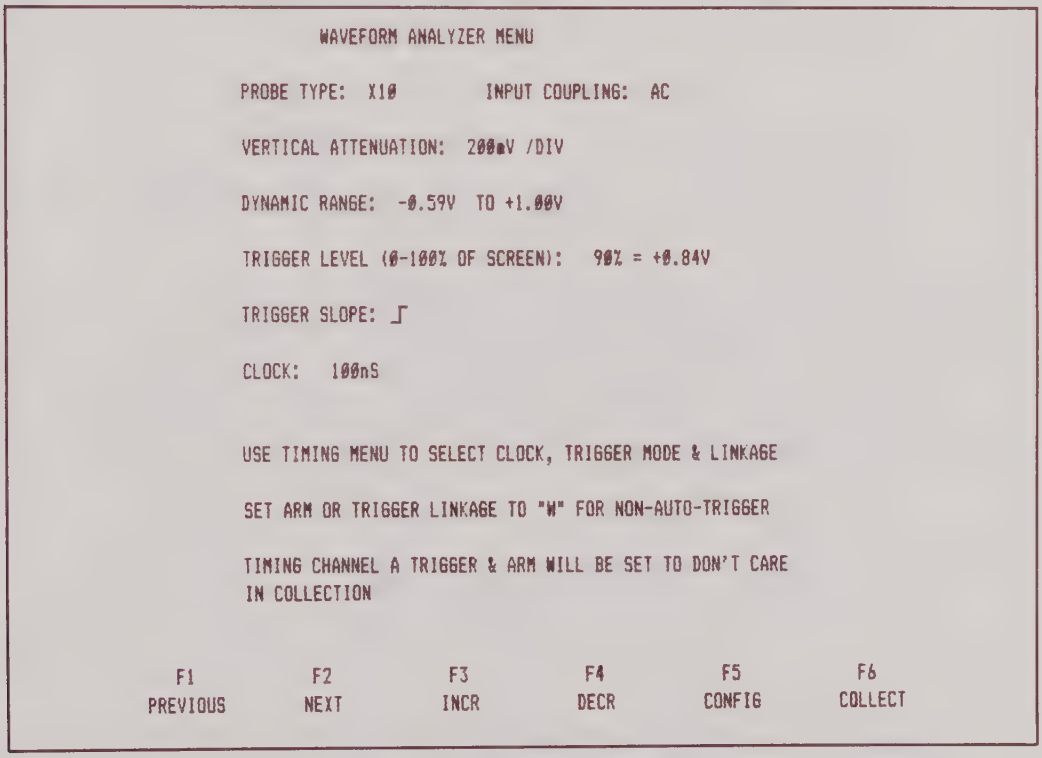
WAVEFORM ANALYZER MENU
PROBE TYPE: X10
INPUT COUPLING: AC
VERTICAL ATTENUATION: 200mV /DIV
DYNAMIC RANGE: -0.59V TO +1.00V
TRIGGER LEVEL (0-100% OF SCREEN): 90% = +0.84V
TRIGGER SLOPE:
CLOCK: 100nS
USE TIMING MENU TO SELECT CLOCK, TRIGGER MODE & LINKAGE
SET ARM OR TRIGGER LINKAGE TO "W" FOR NON-AUTO-TRIGGER
TIMING CHANNEL A TRIGGER & ARM WILL BE SET TO DON'T CARE IN COLLECTION
F1 PREVIOUS
F2 NEXT
F3 INCR
F4 DECR
F5 CONFIG
F6 COLLECT

Figure 3-79. Waveform Menu

```
                    48 CHANNEL STATE SET-UP

FORMAT:  AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA AAAAAAAA
         +A HEX
CLOCKS:
   EXT R=( Cr ⌠ * Qr X )  S=( Cs ⌠ * Qs X )  T=( Ct ⌠ * Qt X )
       MEMORY 1: R        MEMORY 2: R        MEMORY 3: R        MASTER:   R

EVENTS:          Qualifiers: -XYZ EL
 E1 ZERO     =  0000XXXXXXXX -XXX XX

 E2 FIVE     =  0005XXXXXXXX -XXX XX                                  H - HEX

 E3 NUMBER   =  0048XXXXXXXX -XXX XX                                  O - OCTAL

 E4          =  XXXXXXXXXXXX -XXX XX                                  Z - DEC

 E5          => XXXXXXXX                                              N - BINARY

             =( XXXXXXXX                                              Y - ASCII

    TAB - NEXT SENTENCE                          P - PROGRAM MENU
    S1 - DATA DISPLAY                                                 U - USER
   F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT                                CONFIG      COLLECT
```

Figure 3-80A. State Setup Menu

```
                    48 CHANNEL STATE PROGRAM

EVENTS:     E1 ZERO     E2 FIVE     E3 NUMBER   E4          E5

        STOPPING CONDITION: WHEN SEQUENCE DONE
STEP
 1  STORE NONE   . IF 0001 E1 +   THEN GOTO 2  NO LINK. IF       THEN GOTO 1

 2  STORE NONE   . IF 5000 ANY    THEN GOTO 3  NO LINK. IF       THEN GOTO 1

 3  STORE ALL    . IF 0001 E2 +   THEN GOTO 4 AND LINK. IF       THEN GOTO 1

 4  STORE ALL    . IF 0200 ANY    THEN DONE    NO LINK. IF       THEN GOTO 1

 MORE

    TAB - NEXT SENTENCE      DELETE - BLANK LINES     Q - SETUP MENU
    S1 - DATA DISPLAY
   F1          F2          F3          F4          F5          F6
PREVIOUS      NEXT        INCR        DECR        CONFIG      COLLECT
```

Figure 3-80B. State Program Menu

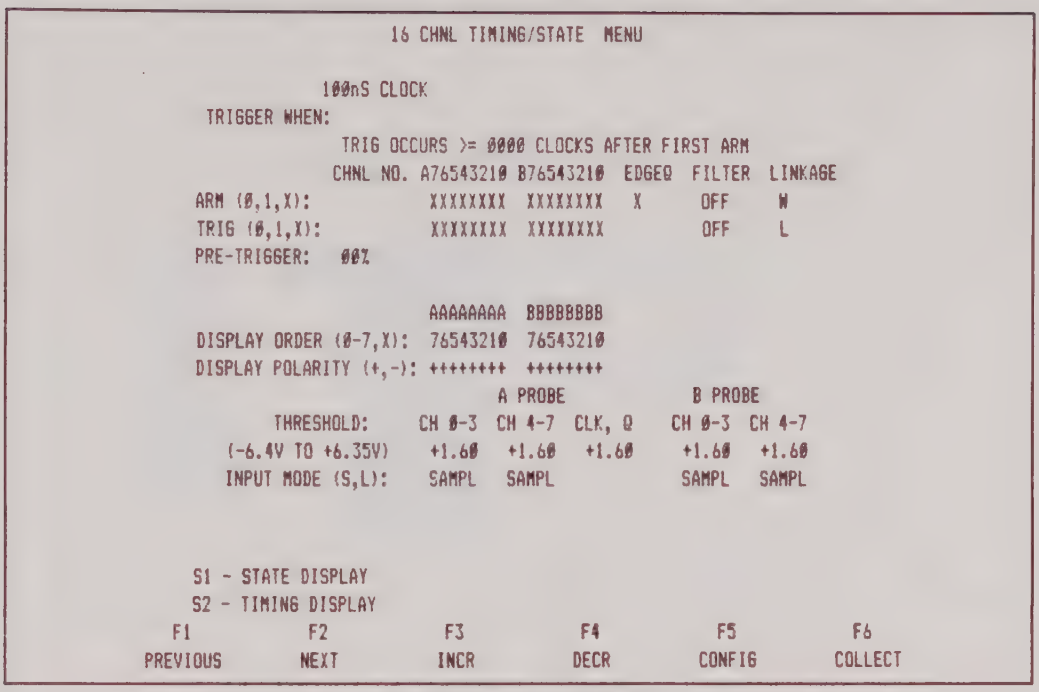
16 CHNL TIMING/STATE MENU
100nS CLOCK
TRIGGER WHEN:
TRIG OCCURS >= 0000 CLOCKS AFTER FIRST ARM
CHNL NO. A76543210 B76543210 EDGEQ FILTER LINKAGE
ARM (0,1,X): XXXXXXXX XXXXXXXX X OFF W
TRIG (0,1,X): XXXXXXXX XXXXXXXX OFF L
PRE-TRIGGER: 00%
AAAAAAAA BBBBBBBB
DISPLAY ORDER (0-7,X): 76543210 76543210
DISPLAY POLARITY (+,-): ++++++++ ++++++++
A PROBE B PROBE
THRESHOLD: CH 0-3 CH 4-7 CLK, Q CH 0-3 CH 4-7
(-6.4V TO +6.35V) +1.60 +1.60 +1.60 +1.60 +1.60
INPUT MODE (S,L): SAMPL SAMPL SAMPL SAMPL
S1 - STATE DISPLAY
S2 - TIMING DISPLAY
F1 F2 F3 F4 F5 F6
PREVIOUS NEXT INCR DECR CONFIG COLLECT

Figure 3-81. Timing Menu

Press COLLECT. State analyzer progresses to step two and waits for trigger word that has been temporarily inhibited. Timing analyzer continues to sample, waiting to be armed. Now insert waveform probe tip into "VIDEO" BNC. This allows waveform recorder to recognize its trigger conditions, which, in turn ARM's the timing analyzer. Because the state analyzer has not yet recognized all of its trigger conditions, the timing analyzer is still not triggered. Remove short (from the test card) on data bit 0. This allows the state trigger sequence to complete, the timing analyzer to TRIGGER, and both the state and timing analyzers to collect data.

There are many other possible linkage combinations which can be set up. Experiment with this feature. These combinations are useful in isolating complex system problems.

3.14 NONVOLATILE MEMORY

The following describes how to store data sets and their associated menu setups in the Nonvolatile Memory option. There are many types of nonvolatile memory currently available. The most popular are battery-backed-up RAM, EPROM, EEPROM, bubble memory, tape drives, and disk drives. Each technique has its own advantages and disadvantages. Because of its speed, relatively low cost, and the benefits it provides when used with the Computer/Controller option, Nicolet Paratronics picked the disk drive technique.

The Nonvolatile Memory option comes with a diskette that has a "Nonvolatile Memory Configuration menu" on it (see Figure 3-82). Pressing "ESC" when viewing the main operational configuration menu automatically loads this menu. When this menu has been loaded from the diskette into RAM, it provides the user with the ability to easily Save and Recall data sets and setups. It also allows the user to select from many bus or microprocessor disassembly programs to display mnemonic data.

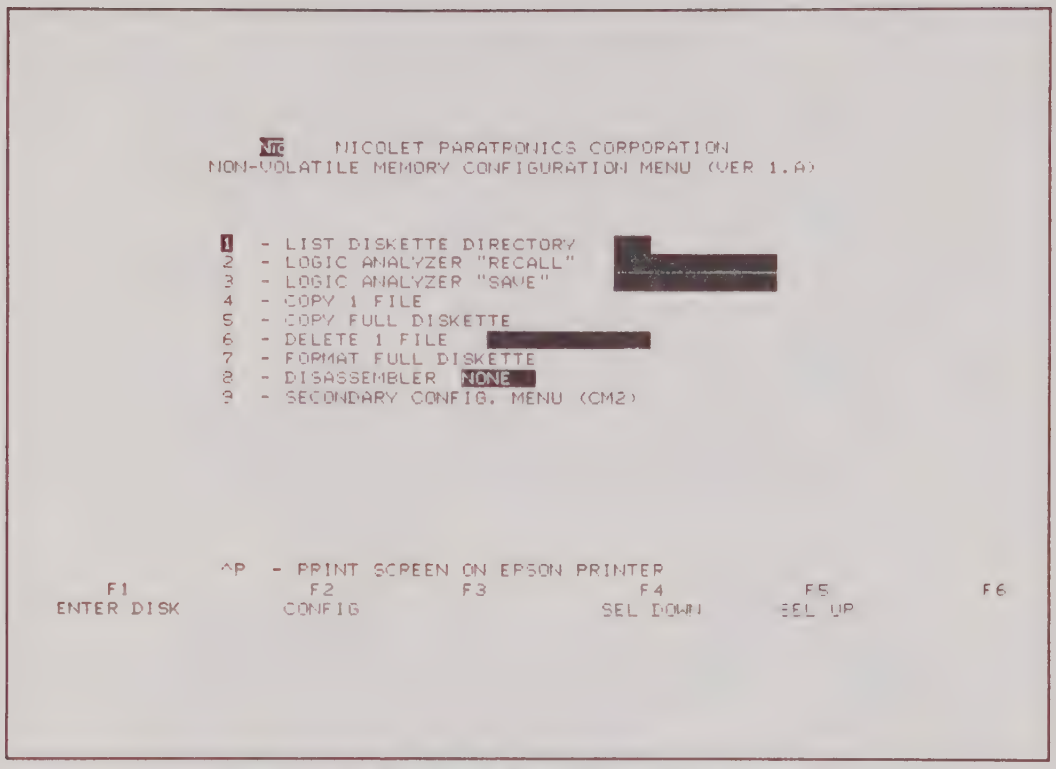
NICOLET PARATRONICS CORPORATION
NON-VOLATILE MEMORY CONFIGURATION MENU (VER 1.A)
1 - LIST DISKETTE DIRECTORY
2 - LOGIC ANALYZER "RECALL"
3 - LOGIC ANALYZER "SAVE"
4 - COPY 1 FILE
5 - COPY FULL DISKETTE
6 - DELETE 1 FILE
7 - FORMAT FULL DISKETTE
8 - DISASSEMBLER NONE
9 - SECONDARY CONFIG. MENU (CM2)
^P - PRINT SCREEN ON EPSON PRINTER
F1 ENTER DISK
F2 CONFIG
F3
F4 SEL DOWN
F5 SEL UP
F6

Figure 3-82. Nonvolatile Memory Configuration Menu

To save a data set, use the soft keys F4 or F5, which select the desired item on the menu. Move cursor to SAVE. Type in desired file name. Press soft key F1 or RETURN to execute SAVE function.
EM
To recall data set or setup, select menu's RECALL line. Type in name of file to recall from the diskette (which obviously must have been saved previously).

3.15 PERFORMANCE ANALYSIS HISTOGRAMS

This option requires the installation of the Nonvolatile Memory option. It provides insight into the total system performance of the target system, or simply to examine the performance time of a subset of the target system.

For example, to examine the percentage of CPU time that several routines are consuming in the "target system," press RESET and select secondary configuration menu. Select event histogram menu and set it up as shown in Figure 3-83. Attach test card to A and B state probes. Press COLLECT. The state analyzer collects a complete data set. Performance Analysis software then examines data set, extracts information, and then displays statistics of that information in bar-chart format. The state analyzer then collects another set of data. The examination process is repeated, to update the bar-chart display. This process is repeated until you press STOP.

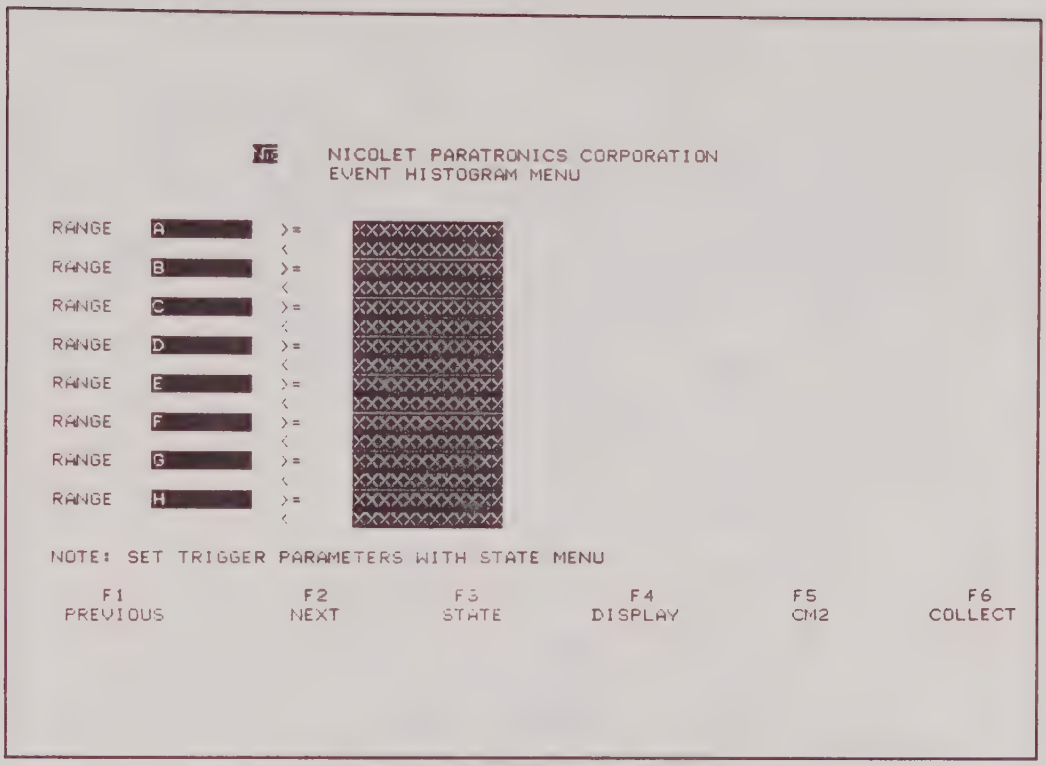

Figure 3-83. Event Histogram Menu

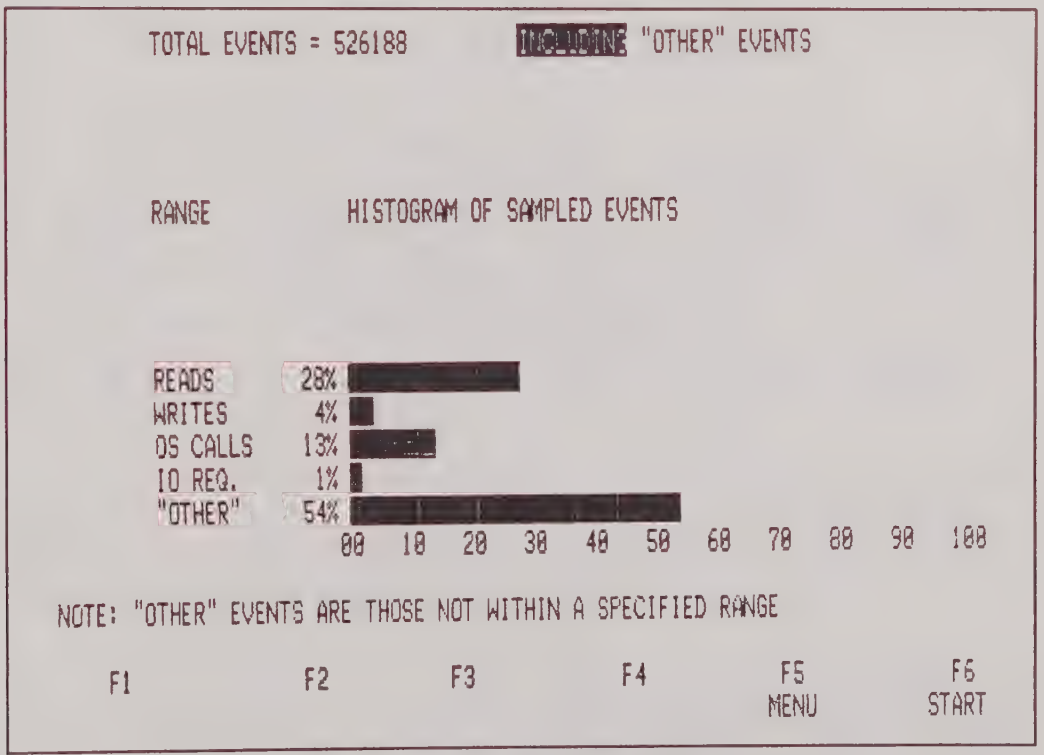

Figure 3-84. Event Histogram Display

To be more specific about which data are collected into the state analyzer (for examination), the state analyzer menu parameters could also be specified.

As an example of examining the performance of a specific "subroutine", halt the previous example, return to secondary configuration menu, and then select time interval menu. Set it up as in Figure 3-85, then press collect. The state analyzer probes route state data to the Counter-Timer option, which measures the time interval between the beginning word of subroutine, and ending word. That time interval is compared to those intervals specified in the menu and "logged" in the appropriate "bin". The time interval is repetitively measured, compared and logged. To show how often the subroutine is executed in the expected time interval, and how often it did not, the results are displayed in bar-chart format.

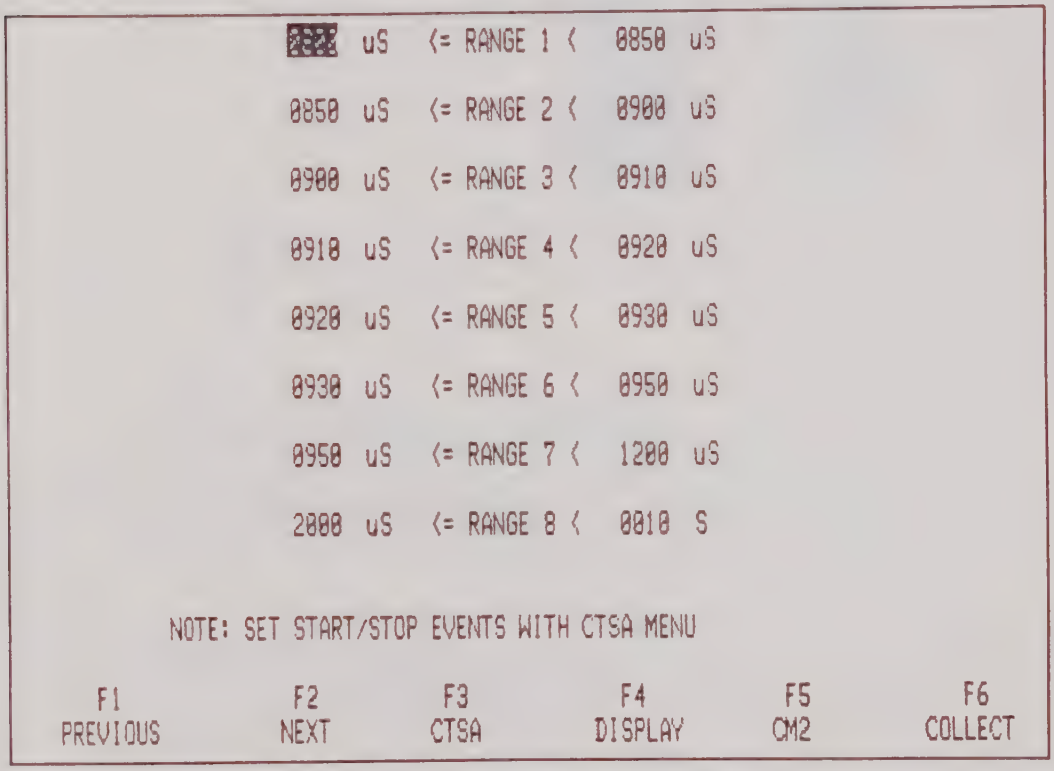
0000 uS <= RANGE 1 < 0850 uS
0850 uS <= RANGE 2 < 0900 uS
0900 uS <= RANGE 3 < 0910 uS
0910 uS <= RANGE 4 < 0920 uS
0920 uS <= RANGE 5 < 0930 uS
0930 uS <= RANGE 6 < 0950 uS
0950 uS <= RANGE 7 < 1200 uS
2000 uS <= RANGE 8 < 0010 S
NOTE: SET START/STOP EVENTS WITH CTSA MENU
F1 PREVIOUS
F2 NEXT
F3 CTSA
F4 DISPLAY
F5 CM2
F6 COLLECT

Figure 3-85. Time Interval Histogram Menu

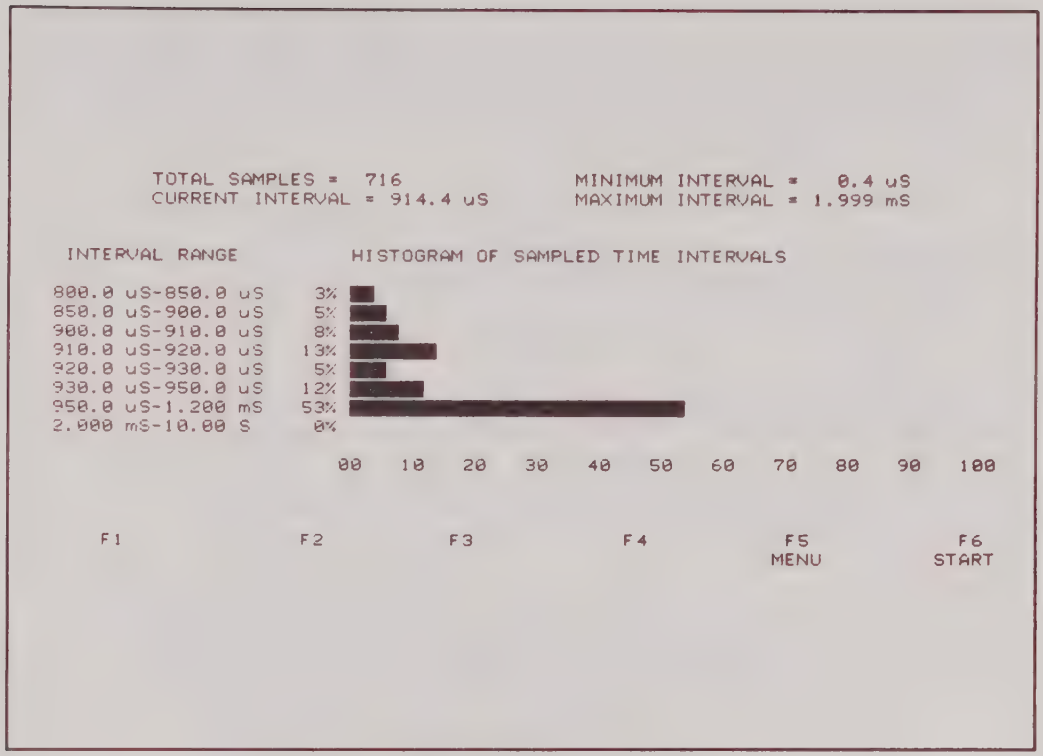

Figure 3-86. Time Interval Histogram Display

The results shown in each of the above performance analyses are then used to determine what might be altered to improve your target system's performance.

3.16 DOT MATRIX PRINTER

The following describes how to use the NPC-800D Printer option. Since the software resides on diskette, the Nonvolatile Memory option must be installed. This software converts the screen information from the NPC-800D to the commands and data necessary to allow the dot matrix printer to duplicate the NPC-800D's screen.

If the printer has been purchased from Nicolet Paratronics, it and the cable are ready for use. If purchased from another source, refer to NPC application note for the Epson MX-80 or Epson RX-80. Setup of internal switches on the printer and modification instructions for the cable (to ensure proper operation) are described in these publications.

Once printer is setup, RS-232C cable installed and software loaded, press two keys to initiate print process: "CTRL" and "P" must be pressed simultaneously to start the printing. Pressing any key stops the printing. Remember, the printer has a 2-kilobyte memory which is emptied before printing actually stops. After pressing a key, transmission between the NPC-800D and the printer stops. The NPC-800D then returns to the Configuration menu.

If any menu, timing display, or counter-timer display are on the screen, the entire screen contents will be printed. If a state data display is on the screen, the print process begins with the top line on the screen and continues printing until the end of current data collection. To stop printing process, if you do not want the entire (remainder) of the state data collection printed, simply press any key. Printing stops when print buffer has been emptied.

Because hardware is used to "write" the analog waveform on the screen (instead of using characters in the screen memory), the printer will not print the analog waveform display. It prints the axes and measurement information, but not the analog signal display.

3.17 DEDICATED PROBES

3.17.1 Dissassembly (Example)

To simplify tracing of a microprocessor's program, NPC offers dedicated probes with disassembly software for most popular 8-and 16-bit microprocessors.

3.17.2 "Disassembling" The Test Card

Even without a dedicated probe, if you have the nonvolatile memory option installed, you can still "disassemble" data patterns from the test card.

Simply connect A and B state probes to corresponding connectors on test card. Call State menu and set A-channel trigger to 0040.

3.17.3 Collect

Press COLLECT key and display data in hexadecimal or any other desired format.

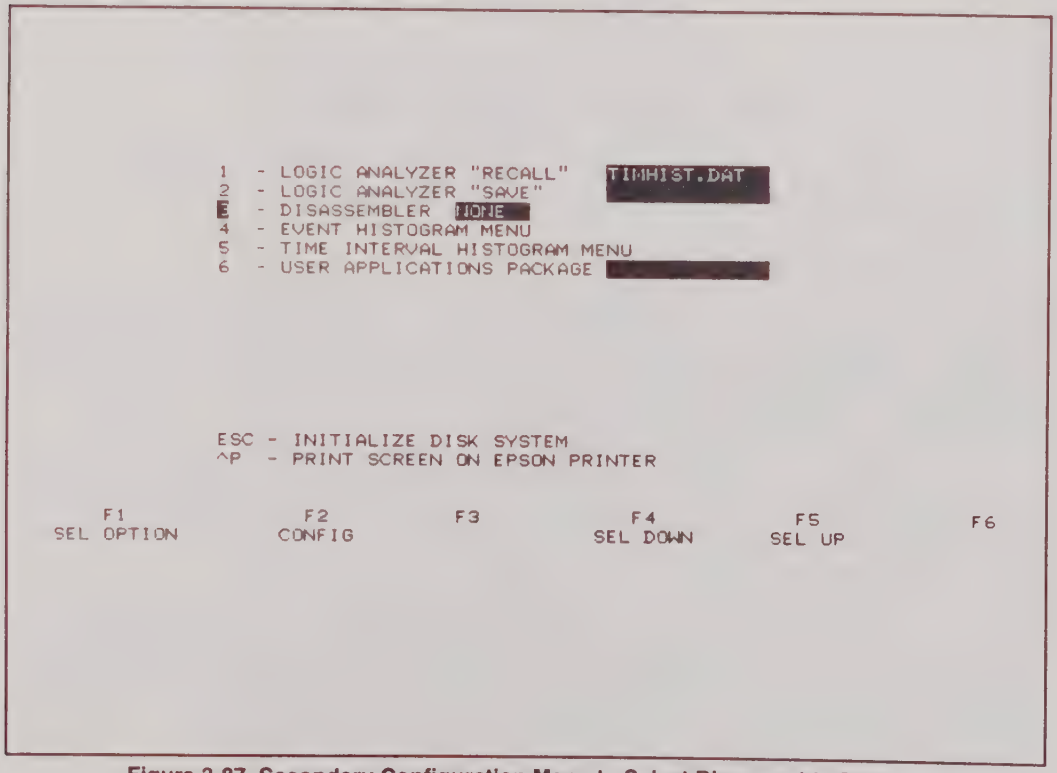
1 - LOGIC ANALYZER "RECALL" TIMHIST.DAT
2 - LOGIC ANALYZER "SAVE"
3 - DISASSEMBLER NONE
4 - EVENT HISTOGRAM MENU
5 - TIME INTERVAL HISTOGRAM MENU
6 - USER APPLICATIONS PACKAGE
ESC - INITIALIZE DISK SYSTEM
^P - PRINT SCREEN ON EPSON PRINTER
F1 SEL OPTION
F2 CONFIG
F3
F4 SEL DOWN
F5 SEL UP
F6

Figure 3-87. Secondary Configuration Menu to Select Disassembly Software

3.17.4 Loading Disassembly Software

Call Secondary Configuration menu and press F4 (Select Down) key to move cursor down to "3 Disassembler." Then use F1 key to select Z80 disassembler. To load to disassembler,press F3 (Load) key. Return to CONFIGURATION LIST by pressing F2 and, using F1 key, return to state analyzer.

3.17.5 Displaying In Disassembled Format

Pressing the 1 key changes the display format to disassembly.

NOTE

Press labels key and observe that 1 is a format option key as are H and 0.

```
MAIN       TRIG  0040  NOP
           +001  0041    01   OPERAND FETCH
LOC: TRIG  +002  0042    02   DATA READ
           +003  0043    03   RE
SIG: C1E7  +004  0044    04   INPUT
     19E7  +005  0045    05   (C)
     D8D3  +006  0046    06   STACK READ
           +007  0047    07   INTERRUPT ACKNOWLEDGE
           +008  0048  DJNZ  005BH
           +009  0049    09   D)
           +010  004A    0A   DATA WRITE
           +011  004B    0B   IM
           +012  004C    0C   OUTPUT
           +013  004D    0D   PORT:
           +014  004E    0E   STACK WRITE
           +015  004F    0F   REFRESH
           +016  0050  DJNZ  0063H
           +017  0051    11   OPERAND FETCH
           +018  0052    12   DATA READ
           +019  0053    13   RE
           +020  0054    14   INPUT
           +021  0055    15   (C)
           +022  0056    16   STACK READ
```

Figure 3-88. Disassembled Display of Arbitrary Test Card Data (Z80 Disassembler Used)

NOTE

Information in Figure 3-88 is meaningless because neither a dedicated probe nor a real microprocessor were used.

3.17.6 Unused State Channels

Since NPC's 8-bit dedicated probes require 32 channels (A & B), there are 16 additional state channels (C) (and 16 additional timing channels) available for monitoring other signals in your system. To view these additional state channels, simply type the key corresponding to desired display format (see LABELS field).

3.17.7 User Format (U)

If a mixed format is used, type U to call all 48 channels (A, B, and C) of state data in that format. Then type 1 to again disassemble data associated with A and B probe inputs.

3.17.8 Serial Analyzer

For serial testing, the NPC-800D requires a Model 70 serial probe. With this probe, RECEIVE, EDIT and TRANSMIT functions are possible. In Receive mode, the Model 70 converts incoming serial data to parallel words for collection by the state analyzer. Captured data can be displayed in ASCII or any other available format. To display received data shown in menu in Figure 3-89, transfer collected data from main state memory to auxiliary memory. To do this, press S (SAVE) key after data collection.

EDIT and TRANSMIT modes operate on whatever ASCII characters are in the data field shown in Figure 3-89. Instructions for using these modes are contained in the menu itself. For additional details, consult the Model 70 User's Instructions (available from nearest NPC sales office).

```
                    PI MODEL 70 TRANSMIT

      1   5    10   15   20   25   30   35   40   45   50
      |---+----|----+----|----+----|----+----|----+----|
001   THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG
051   0123456789
101
151
201

CHARACTER COUNT: 61

     ENTER DATA IN: ASC  (USE F1 KEY)
     SEND DATA BIT 8 AS 0  (USE F3 KEY)

     ^L (RIGHT), ^H (LEFT), ^J (DOWN), ^K (UP) TO MOVE CURSOR

      S2 - CONTINUOUS XMIT (ANY KEY TO STOP)

      S1 - ESCAPE KEY FOR SPECIAL KEYS

  SET A CLK TO 1 TO RECEIVE DATA THROUGH THE M70 PROBE

  F1          F2          F3          F4          F5          F6
 BASE        CLEAR       BIT 8      END DATA    CONFIG      XMIT
```

Figure 3-89. Model 70 EDIT and TRANSMIT Menu

NOTE

Cursor commands shown in menu: CTRL L (RIGHT) and CTRL H (LEFT), are used when data entry base is hexadecimal or octal. When data entry base is in ASCII, it's easier to use the SPACEBAR and BACKSPACE keys for simple editing.

3.17.9 Available Dedicated Microprocessor Probes/Disassembly

Call factory for appropriate Application Notes

8080	— Model 55	6800	— Model 57
8085	— Model 56	6802	— Model 57
8086	— Model 59	6808	— Model 57
8088	— Model 65	6809	— Model 62
Z80	— Model 58	6809E	— Model 63
6502	— App Note	6800O	— Model 64

3.17.10 Available Dedicated Bus Probes

Call factory for appropriate Application Notes.

RS-232C — Model 70
RS-232C/MIL-188C/RS-422/3 — Model 71
IEEE-488 — App Note
DEC UNIBUS — App Note

3.17.11 General Purpose Interface Probe

3.17.12 Nicolet In-circuit Emulators (NICE)

Z80	— NICE Z80
8085	— NICE 8085
N S C 800	— NICE NSC 800
8088	— NICE 8088

ADDRESS LIST is an ASCII string that specifies which bus devices are to be set to LOCAL (front panel) operation (see paragraph 3.19.74 for data format).

1. ADDRESS LIST = "valid format" data (see paragraph 3.19.74). Used when NPC-800D is active controller and specifies bus LISTENERS.

2. ADDRESS LIST = NULL. Used when NPC-800D is not active controller.

Purpose:

Transmit ASCII data from NPC-800D to other bus devices

Return Code:

3.18 COMPUTER/CONTROLLER

3.18.1 General-Purpose Computer

As described in the introduction, the NPC-800D is not only a very capable logic analysis system, it is can also be configured to be a general-purpose, desk-top microcomputer. Since the logic analyzer has been thoroughly described in previous sections of this manual, this section deals only with the microcomputer aspects of the NPC-800D.

All microcomputers are comprised of a hardware system and a software system. Unless used for a single, specific task, the software system is called an "operating system." The purpose of an operating system is to provide the interface between the hardware and the user.

3.18.2 Hardware Display

The following are three display techniques available to the user of the NPC-800D. A 9-inch CRT with 25 lines of 80 character positions each for integral display. A BNC connector on the back panel permits standard RS-170 composite video information from the CRT to also be displayed on an external video monitor or printer. And, for display, an RS-232C interface permits the transmission of information to an external terminal, printer, or another NPC-800D system.

3.18.3 Keyboard

A full ASCII keyboard, familiar to most users, has seven special function keys at the top, plus a RESET key. In the Reset mode, the RESET key calls the Logic Analyzer Operating System (it must be held down for approximately two seconds). This time delay is needed to prevent an accidental reset at an inopportune time. When operating the NPC-800D as a logic analyzer, or user-defined for Microcomputer mode, six other special keys are predefined.

3.18.4 Memory Subsystem

There are 48K bytes of RAM available to the user. Since the NPC-800D's 8085 microprocessor cannot directly address this 48K bytes of RAM and an additional 40K bytes of analyzer ROM, memories are "bank switched," enabling only one memory bank at a time.

3.18.5 Disk Drive

Both integral flexible disk drives are 5¼-inch, double-sided, double-density, soft-sectored, 96 tracks per inch (80 tracks) with 600K bytes of formatted capacity. Refer to Section 2 for diskette specifications. Using an external dual-drive expansion chassis, a connector is provided to expand disk memory to approximately two megabytes, unformatted. Using a serial-driven disk subsystem, the RS-232C interface can also be used to extend the disk memory.

3.18.6 I/O

The RS-232C interface on the NPC-800D provides a "standard" interface to serial devices. This bidirectional interface is described in paragraph 3-20.

3.18.7 Controller

The NPC-800D also incorporates an intelligent controller for the IEEE-488 interface bus. Commands that permit execution of user programs to control an IEEE-488 bus-based system are described in paragraph 3-19.

3.18.8 Software

As stated previously, an "operating system" is a program designed to provide an interface between the user and the hardware. The NPC-800D actually has two operating systems; the logic analyzer operating system, which is in ROM, and CP/M, which is loaded from disk into RAM (CP/M is a trademark of Digital Research).

The ROM-based operating system for the logic analyzer requires little explanation because the functions of this system are fixed and dedicated to controlling logic analyzer hardware.

In contrast, user interface to the microcomputer cannot be defined specifically because of the great diversity of application software available to be purchased or created by the user. Therefore, a description of CP/M is included.

3.18.9 CP/M

For the 8080, 8085, and the Z80 microprocessors, CP/M is one of the most commonly used operating systems. Reasonably priced programs are available that perform a wide variety of applications, from word processing to scientific data analysis.

Through CP/M, the user can also create his or her own programs. These programs can be machine-code, generated via assembly language by a resident assembler, or they can be generated using a high-level language such as BASIC or FORTRAN. CP/M can also be used to set up and control the analyzer and then post-process analyzer data.

3.18.10 CBASIC

CBASIC is also provided with the computer option. This version of BASIC was chosen because it is easy to use, allows variable names 31 characters long, and eliminates some documentation tasks. It also uses a pseudo-compiler that reduces execution time.

3.18.11 CP/M Overview

This NPC-800D Operator's Manual is intended to guide the user in the application of CP/M, not to provide a tutorial nor to make the user proficient in its use. The following information is an overview of CP/M. It also offers basic examples of some of CP/M's features and commands. For more detailed knowledge of CP/M and its applications and/or modifications, refer to the CP/M Documentation Manual provided with the NPC-800D.

The CP/M operating system is literally a system of interrelated programs. Rather than load all CP/M into memory at once and unnecessarily consume RAM memory space, hardware memory is partitioned such that one section contains the core of the operating system (hereafter referred to simply as "the system"), while the remaining programs reside in an area of memory designated as "transient program area." These transient programs are loaded into shared memory only when needed.

There are two kinds of commands available in CP/M: built-in and transient. Built-in commands are five of the most commonly used commands which are part of the core of the CP/M system and do not appear on the disk directory. Transient commands are so named because they are actually programs that generally appear in the disk directory. When called, they are loaded into the Transient Program Area (TPA) of RAM. After loading into RAM, each transient program has its own set of commands which can be executed.

3.18.12 Built-In Commands

DIR - command used to display the disk directory.

TYPE - used to simply examine a disk source file listing only, by displaying file on the CRT, exactly as it is stored on disk.

SAVE - used to transfer transient program area of RAM memory to disk. Normally this program would be used to save programs generated by ASM.

REN - renames an existing file on the disk. It will not create a new copy of the old file, merely assigns a new name.

ERA - erases an unwanted file from the disk.

File labeled: READ ME describes other files on diskette. To access this file, type: TYPE READ.ME. Then press CNTL S to stop and any key to resume scrolling.

3.18.13 Transient Commands

SYSGEN - does not appear in the disk directory. Used to generate a new bootable system disk for use as a backup copy. Because of copyright restrictions, CP/M may not be copied.

STAT - displays remaining memory space on disk or displays the size and other characteristics of a specific file.

ED (and associated commands) - performs a simple line-oriented text editor function. It is not a word processor, but a tool to use in creating and editing files. These files can be simple text or high-level programs to be compiled later.

PIP - handles and manipulates the program. Used to copy files, transmit and receive data on the RS-232C interface, and, for file handling, assigns physical devices to logical device names used in PIP.

SUBMIT - Specifies a series of CP/M commands to be executed sequentially. This series can be stored as a file, then called any time the user wishes to perform that series of commands — without having to type them from the keyboard each time.

XSUB - an extended submit program that allows a series of commands to be linked into a file; and which also stops and permits user to insert variable information into specific elements of the command list.

ASM - an assembler program for the 8080/8085. It allows the user to create 8080/8085 executable code using assembly language. This 8080/8085 code thus generated may be used in the NPC-800D or it can be transmitted, using PIP, to an external device, such as a PROM programmer. There are similar programs for other microprocessors available from software suppliers.

DDT - used to debug programs created with ASM. It tests the program and permits editing.

LOAD - used to convert a program from a ".HEX" file created by ASM into an executable ".COM" file. As conversion takes place, the program is loaded into executable memory space.

DUMP - used to display a file from disk in HEX form rather than ASCII.

3.18.14 NPC Transient Commands CM2P.COM

3.18.15 Secondary Configuration Menu

Allows the following selection:

1. Time histogram
2. Event histogram
3. Print routine for Epson Series graphics printer on the RS-232 port
4. LASAVE.COM
5. LARECALL.COM
6. Disassemblers
7. Load and execute user supplied subprograms

UC2.COM - sample user program that can be loaded and executed using CM2.COM. Program displays entire NPC-800D character set.

UC2.LST - source listing of sample user program UC2.COM.

D8080 - 8080 microprocessor disassembler software

D8085 - 8085 microprocessor disassembler software

D6800 - 6800 microprocessor disassembler software

D6809 - 6809 microprocessor disassembler software

D6809E - 6809E microprocessor disassembler software

D488IEEE - IEEE-488 disassembler software

D8086 - 8086 microprocessor disassembler software

D8088 - 8088 microprocessor disassembler software

D68000 - 68000 microprocessor disassembler software

DZ80 - Z80 microprocessor disassembler software

FORMAT1.COM - program to format a single-sided diskette for operation on the NPC-800D system; external drives only.

FORMAT2.COM - program to format and copy the CP/M operating system on a double-sided diskette on the NPC-800D system.

KYBDTEST.COM - program used to test NPC-800D keyboard.

LA.COM - program used to return to NPC-800D firmware from CP/M disk operating system without resetting NPC-800D.

LASAVE.COM - program used to save NPC-800D set-up and collected data into a disk file

Format - LASAVE D:FILENAME.XXX

LARECALL.COM - program used to recall from diskette the NPC-800D set-up and data stored by the LASAVE program.

Format - LARECALL D:FILENAME.XX

LADISA.COM - program used to load a disassembler from diskette for use by logic state analyzer firmware.

Format - LADISA D:FILENAME.XX

RAMTEST.COM - program used to test dynamic RAM and state analyzer static auxiliary RAM.

3.18.16 Files To Be Executed Using CBASIC Interpreter

GPIBEX.BAS - source code file of an example program that exercises NPC-800D GPIB functions.

GPIBEX.INT - intermediate code file of an example program that exercises NPC-800D GPIB functions.

GPIB.BAS - source file written in BASIC that can be included in a BASIC program to allow high level language access to the GPIB controller and device functions.

LADISC.BAS - source file written in BASIC that can be included in a BASIC program to allow the saving and recalling of NPC-800D set-up and data files from a BASIC program.

RS232EX.BAS - source code file of an example program that exercises operating system control of the NPC-800D and exercises NPC-800D-to-NPC-800D operation over the RS-232C interface.

RS232EX.INT - intermediate code file of an example program that exercises operating system control of the NPC-800D-to-NPC-800D operation over the RS-232C interface.

RS232EX.001 - LASAVE file used by RS232EX program.

RS232EX.002 - LASAVE file used by RS232EX program.

SAVREC.ASM - source file in 8085 assembly used by LADISC.BAS to allow SAVE/RECALL of analyzer data files.

SAVREC.COM - COM file of SAVREC.ASM read by LADISC.BAS to perform LASAVE and LARECALL.

3.18.17 CB-80, Compiled Basic

Some customers have asked for a language that executes their applications programs faster than CBASIC. CB-80 is faster executing BASIC, but it generally consumes more time during program debug. However, you may purchase the CB-80 compiler and use the following files instead of those for CBASIC.

3.18.18 Files For Compilation By CB-80

GPIBEX80.BAS - source file written in CB-80 of an example program that exercises NPC-800D GPIB functions.

GPIBEX80.REL - relocatable binary file generated from assembling GPIBEX80.BAS.

GPIB80.BAS - source file written in CB-80 that can be included in a BASIC program to allow high-level language access to GPIB controller and device functions.

GPIBPS80.REL - relocatable binary file that is used with the GPIB80.BAS file to allow higher level access to the GPIB controller and device functions. The routine provides call access to absolute addresses from the CB-80 program.

GPIBPS80.MAC - source program for GPIBPS80.REL file. It requires an assembler that generates a relocatable binary file.

LADISC80.BAS - source file written in CB-80 that can be included in a BASIC program to allow the saving and recalling of NPC-800D set-up and data files from a CB-80 program.

SAVREC80.MAC - source file used with LADISC80.BAS to allow saving/recalling of NPC-800D analyzer data.

SAVREC80.REL - relocatable binary file generated by assembling file SAVREC80.MAC.

GPIBEX80.COM - executable file generated by compiling GPIBEX80.BAS BASIC program with CB-80.

3.18.19 Use Of LASAVE and LARECALL From a CBASIC Program

A file is provided on floppy disk (named LADISC.BAS) that provides the function definitions necessary to save or recall analyzer set-ups and data while executing a CBASIC program. This information is useful in automated testing. It recalls canned set-ups or "known-good" data and saves the results for later analysis.

To use these functions, first compile a CBASIC test program with LADISC.BAS (included prior to the first program access). This can be done with the CP/M editor or, at compile time, by using the following CBASIC statement:

```
%INCLUDE LADISC
```

To execute LASAVE, use the statement format:

```
RC% = FN.LASAVE% ( filename$ )
```

To execute LARECALL, use the statement format:

RC% = FN.LARECALL% (filename $)

filename $ is any valid CP/M file name.

RC% contains a return code, as follows:

0 = normal execution
1 = disc full (save only)
2 = no such filename (recall only)
3 = invalid filename

3.18.20 CP/M Examples

This is a description of the steps you may need to perform some of the more available, commonly-used commands. Although you will not receive an in-depth knowledge of CP/M and its facilities, the examples that follow show you how to perform basic text file creation, limited file manipulation, 8080/8085 code generation and debug, and how to get a hardcopy of your files. You'll also be able to exercise control over the execution of logic analyzer tests saved on disk.

3.18.21 Power On

If power is already on, it is not necessary to turn power off and back on. Insert CP/M diskette in accordance with Section called CONFIGURATION LIST; press ESC (ESCAPE) key. If power is off, turn it on at rear of right side of unit BEFORE INSERTING DISKETTE.

3.18.22 Header

The system responds with a header identifying the current version of the CP/M operating system. The system also displays a prompt to signify that it is ready for operator input:

A>

DIR

DIR is used to display the disk directory. Simply type DIR and press RETURN:

A>DIR(RETURN)

The CRT should now display the contents of the disk. A identifies disk drive in use. If dual-disk expansion capabilities are used, a B or C is displayed.

3.18.23 STAT

STAT is a transient command used primarily to determine how much DISK MEMORY is remaining, or the size of a particular file.

Type:

STAT (RETURN)

The above command will display the remaining disk memory.

```
stat
A: R/W, Space: 68k


A>
```

Figure 3-90. Response To Request For Space Status On Disk

Next, type:

STAT RAMTEST.COM (RETURN)

```
 Recs  Bytes  Ext Acc
    8     4k    1 R/W A:RAMTEST.COM
Bytes Remaining On A: 68k

A>
```

Figure 3-91. Using "STAT" Command To Determine Size Of File

This command displays the size of any file using the format: STAT FILENAME.EXT $S. Select another file from your directory and try this command again.

NOTE

You must enter all commands exactly as shown with all spaces and characters specified; otherwise the NPC-800D responds with a File Not Found or other error message.

3.18.24 ED

Used for the creation of files, ED is a simple implementation of a text editor. These files can be text, or they can be a high-level-language program that is compiled later.

ED has its own set of commands that only operate after ED has been executed. Those commands allow you to create text, edit it, store it on disk, and retrieve it from disk.

For this example, only a small portion of those commands is used. Therefore, it is IMPERATIVE THAT YOU FOLLOW THIS EXAMPLE PRECISELY. Otherwise, you may get into a situation in which this example will not help you recover.

NOTE

If you get into trouble, press RESET and ESC and start again. Be certain that CAPS LOCK key is locked in the down position.

Type:

ED TESTFILE.TXT (RETURN)

If this file does not already exist, ED returns with a prompt:

NEW FILE

:*

3.18.25 INSERT

Next, we must prepare to INSERT text into our file using the I command. Type:

I (RETURN)

ED is now ready to accept text into line 1:

1:

Begin typing the following text, ending each line with the RETURN key. (To maintain readability, it is suggested that each line be no more than 80 characters.) ED provides a new line number each time you press RETURN.

1: THE NPC-800D REPRESENTS A NEW TREND IN THE TEST AND MEASUREMENT INDUSTRY.

2: THE INTERNAL COMPUTING POWER OF THE MICROPROCESSOR IS NOW AVAILABLE TO THE USER.

3: TASKS SUCH AS AUTOMATIC TESTING, POSTPROCESSING, AND TEST FUNCTION EXPANSION ARE EASILY IMPLEMENTED.

To end the Text Insertion mode, simply press CTRL and Z simultaneously. Then press RETURN.

To end this session with ED,

Type:

E (RETURN)

The system now stores this text file on disk. When it returns with system prompt, A>, you may use DIR to see your new file in the directory. Notice that the system also creates a backup file, TESTFILE.BAK. You can use STAT to examine the file size if desired.

3.18.26 TYPE

TYPE is a built-in command used for quick and easy examination of source file contents. When executed, it displays the file exactly as it is stored on the disk.

Type:

TYPE TESTFILE.TXT (RETURN)

If you are examining a large file, you may want to stop the text before it scrolls off the CRT. Simultaneously press CTRL and S to stop scrolling; press any key to continue scrolling.

3.18.27 REN

REN renames an existing file. It does not duplicate the file under a new name, it merely changes the old name to the new one:

Type:

REN NEWNAME.DOC=TESTFILE. TXT (RETURN)

As an example of REN, execute the following commands:

REN CHECKIT.OUT=READ.ME

DIR allows you to verify that the file name has been changed.

3.18.28 ERA

ERA erases the specified file, FOREVER. Be certain that you specify the correct file. There is no way to recover erased files.

Type:

ERA NEWNAME.DOC (RETURN)
ERA TESTFILE.BAK (RETURN)

3.18.29 FORMAT 1 AND FORMAT 2

FORMAT 1 and FORMAT 2 are special transient commands supplied by Nicolet Paratronics. Since SYSGEN is not supplied with this system, FORMAT 1 and FORMAT 2 are used to format a new diskette (or reformat a used one) in preparation for use.*

Type:

FORMAT 2 (RETURN)

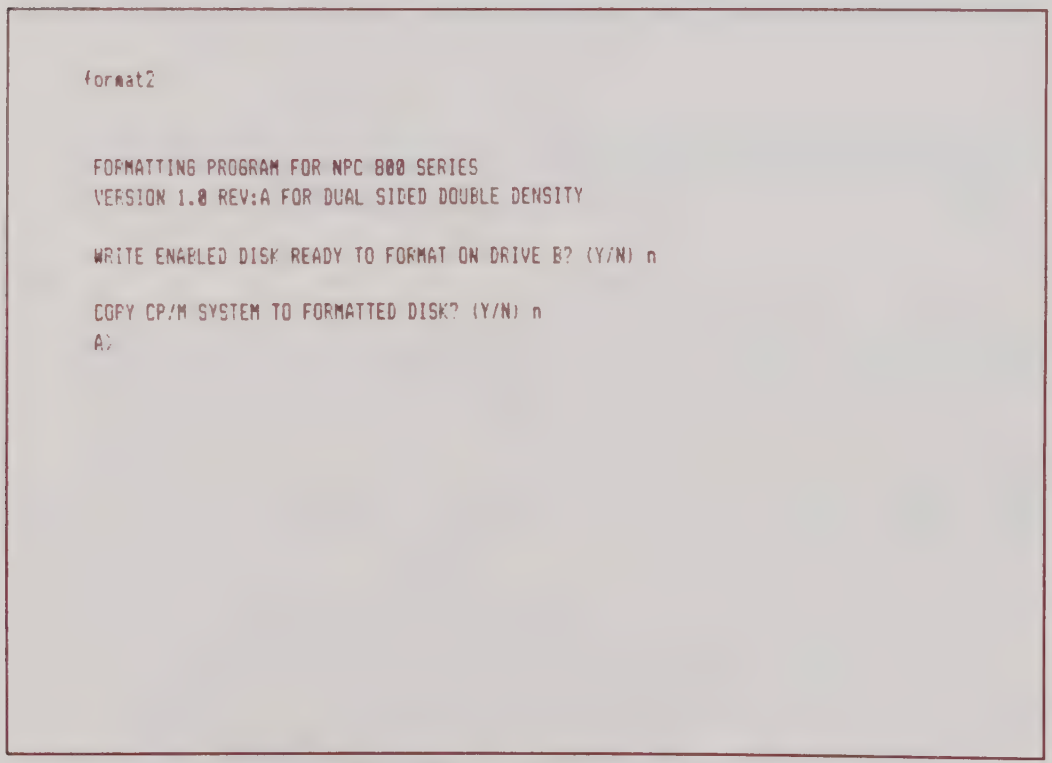
format2
FORMATTING PROGRAM FOR NPC 800 SERIES
VERSION 1.0 REV:A FOR DUAL SIDED DOUBLE DENSITY
WRITE ENABLED DISK READY TO FORMAT ON DRIVE B? (Y/N) n
COPY CP/M SYSTEM TO FORMATTED DISK? (Y/N) n
A>

Figure 3-92. FORMAT 2, Used To Format New NPC-800D Disk.

If desired, insert a "Write Enabled" blank diskette.

Type:

Y (RETURN)

The disk drive turns on and begins formatting the diskette.

*Both FORMAT commands erase all programs listed in the directory on your diskette. Use FORMAT 2 for the NPC-800D integral disk drives. If you are using external drives, which are single-sided, then use FORMAT 1.

3.18.30 ASM

ASM is the transient command which provides the ability to write an assembly language program for the 8080 or 8085. The following example illustrates the mechanics of writing a simple assembly language program using ED, assembling the program using ASM, converting the program to an executable file using LOAD, and finally, executing the program. For a detailed explanation of this procedure, refer to the CP/M Software Documentation Manual.

The first step in writing a program is to define the task to be performed. This example simply displays a message on the NPC-800D CRT. The next step is to create a file, using ED, with MSSGDISP as the main file name and .ASM as the file name extender. A sample file is shown in Figure 3-93.

```
;*********************************************************************
;* this is a test program to illustrate the use of the assembler     *
;*********************************************************************
        org     0100h
rdbtest:lxi     b,dstart        ;ld start address
        lxi     h,0f100h        ;ld output address
start:
        ldax    b               ;ld data to accum.
        cpi     '$'             ;is data byte at end of string?
        jz      exit            ;yes,jmp to end and exit pgrm
        mov     m,a             ;move data byte to ram
        inx     h               ;inc data address
        inx     b               ;inc output address
        jmp     start           ;go back & ld next byte
exit:   ret                     ;finish
dstart: db      'this is an example.....$'
        end

A>
```

Figure 3-93. Sample Source File Created By ED

3.18.31 .PRN FILE

After your program is written and stored on diskette, it must be assembled. Typing ASM MSSGDISP causes the transient program ASM to be loaded. ASM then loads MSSGDISP.ASM and creates two new files, MSSGDISP.PRN and MSSGDISP.HEX. The .PRN file is the one to be used when printing the source file (see Figure 3-94).

```
                ;************************************************************************
                ;* this is a test program to illustrate the use of the assembler      *
                ;************************************************************************
0100                    org     0100h
0100 011301     rdbtest:lxi     b,dstart        ;ld start address
0103 2100F1             lxi     h,0f100h        ;ld output address
                start:
0106 0A                 ldax    b               ;ld data to accum.
0107 FE24               cpi     '$'             ;is data byte at end of string?
0109 CA1201             jz      exit            ;yes,jmp to end and exit pgrm
010C 77                 mov     m,a             ;move data byte to ram
010D 23                 inx     h               ;inc data address
010E 03                 inx     b               ;inc output address
010F C30601             jmp     start           ;go back & ld next byte
0112 C9         exit:   ret                     ;finish
0113 7468697320start:)  db      'this is an example.....$'
012B                    end

A
```

Figure 3-94. Sample .PRN File Created By ASM

3.18.32 .HEX FILE

By using the transient program LOAD, the .HEX file (see Figure 3-95) creates the executable file. Typing LOAD MSSGDISP loads MSSGDISP.HEX and creates the file MSSGDISP.COM.

```
type rf.hex
:10010000011301210 0F10AFE24CA1201772303C35F
:1001100002601C9746869732069732061 6E2065786F
:0801200061 6D70 6C652E2E2E2E2E24BB
:00000000FF

A
```

Figure 3-95. Sample .HEX File Created by ASM

The file MSSGDISP.COM is now available to be executed.

Type:

MSSGDISP (RETURN)

3.18.33 EXECUTE

The NPC-800D now displays the message "THIS IS AN EXAMPLE OF THE ASSEMBLER" near top of CRT.

Using ED and steps illustrated above, you can change original file MSSGDISP.ASM, or create your own new program.

3.18.34 SUBMIT

The SUBMIT utility program allows the user to automatically, and sequentially, execute a series of CP/M command files.

To use this feature of CP/M, simply create a file, using ED (which contains a sequential list of the CP/M command files to be executed). Then type:

A >SUBMIT FILENAME

CP/M loads SUBMIT which in turn causes all lines from FILENAME to be sequentially read and executed. When finished, prompt A appears, indicating that the NPC-800D is ready for the next command from the keyboard.

3.18.35 Executing CP/M Commands

The following example demonstrates how to use SUBMIT to execute, automatically, several CP/M commands discussed previously. In this example, the file name is DEMOFILE. Simply follow the listing in Figure 3-96 (remember to type CTRL Z at line 7 to terminate command entry).

```
ed demofile.sub

NEW FILE
     : *i
    1:  dir
    2:  era *.bak
    3:  stat *.com $s
    4:  dir
    5:  ;       comment statement
    6:  :       This completes demofile.
    7:
     : *e

A`
```

Figure 3-96. Example of SUBMIT Utility

*If necessary, consult the CP/M Software Documentation Manual for editing procedures required to correct program entry errors.

To execute, type:

A>SUBMIT DEMOFILE (RETURN)

At this point, CP/M loads SUBMIT utility and sequentially executes commands and text in DEMOFILE as follows:

1.	DIR	Displays directory of diskette, including back-up files (if any).
2.	ERA *.BAK	Erases all backup files.
3.	STAT *.COM $S	Displays statistics of all .COM files.
4.	DIR	Displays updated directory (without backup files).
5.	;	(Blanks line for spacing).
6.	; THIS COMPLETES	(Comment).

*If necessary, see CP/M Software Documentation Manual for editing procedures required to correct program entry errors.

3.18.36 Executing Analyzer Tests

One of the most powerful advantages of combining logic analysis with CP/M is the simplicity with which multiple tests, including user prompts, can be automated. In the following example, three separate analyzer tests and corresponding test instructions are created, stored, and executed using SUBMIT.

3.18.37 State Test

1. Press RESET to access analyzer operating system. Call 48 Channel State menu and enter 0040 as trigger word (leave all other menu parameters unchanged).

2. Connect A state probe to A side of Logic Analyzer Test Card supplied with NPC-800D (see Section 3.14 for a description of test card). State probe switches should be set to TTL and TRUE.

3. Press COLLECT to take and display a data collection. Save data in the auxiliary memory by pressing S.

4. Press CONFIG followed by ESC key to call CP/M operating system. When A prompt appears, type:

LASAVE STATE (RETURN)

to save the first test under the arbitrary file name: STATE.

(when test is saved, CONFIGURATION LIST automatically appears).

3.18.38 Timing Test

1. Call 16 Channel Timing menu. Enter in a sample clock of 100 microseconds and trigger word of XXXXXXXX 00000000 (X = don't care). Also set PRETRIG to 00%.

2. Connect B timing probe to B side of test card. Then press COLLECT to take and display a data collection. Use X20 magnification. Save data in auxiliary memory by pressing S.

3. Call CONFIGURATION LIST and press ESC as before.

Type:

LASAVE TIMING (RETURN)

to save second test under arbitrary file name: TIMING.

3.18.39 Waveform Test (Optional Waveform Board Must Be Installed)*

1. Call Waveform Recorder menu. Set ATTENUATOR to 1V/DIV and Dynamic Range (−) 1.6 volts to (+) 6.4 volts.

2. Press S2 key to access Display mode. In this mode, press C key to call clock field in Timing menu. Set this clock to one microsecond. Step down to trigger LINKAGE field and select W for single-shot operation.

3. Connect Model 90 probe to WAVEFORM BNC at rear of NPC-800D (Make sure it is not connected to the CTSA BNC). With X10 selected, place probe tip at WF test point on test card and press COLLECT (Remember to connect probe ground wire). Select X1 magnification when waveform is displayed. Save data in auxiliary memory by pressing S key.

4. Call CONFIGURATION LIST and press ESC as before.

Type:

LASAVE WAVE (RETURN)

to save third test under arbitrary file name: WAVE.

*If you've renamed LASAVE as S, type S STATE (RETURN) to save data.

If your NPC-800D does not have this option, continue with the procedure and ignore all references to waveform.

3.18.40 Directory

Press ESC and type DIR (RETURN) to verify that you have STATE, TIMING, and WAVE files on the diskette.

3.18.41 Operator Prompts

Using ED utility, you can create a message that prompts the user for each test. However, to keep the message on the screen until the user is ready to continue, a PAUSE program is required.

3.19.42 Automatic Testing

The SUBMIT program, which controls the logic analyzer, is called AUTOTEST. To incorporate prompting messages prior to each test, follow the procedure described below:

3.18.43 PAUSE

The PAUSE program in Figure 3-97 is written in assembly language.

```
ed pause.asm

NEW FILE
     : *i
    1:          org     0100h
    2:          mvi     c,1
    3:          call    5
    4:          ret
    5:
     : *e

A>asm pause.aax
CP/M ASSEMBLER - VER 2.0


 0100                   org     0100h
 0100 0E01              mvi     c,1
 0102 CD0500            call    5
 0105 C9                ret
0106
000H USE FACTOR
END OF ASSEMBLY
```

Figure 3-97. PAUSE Program

When typing the program in Figure 3-97, press TAB key to achieve the spacing shown. Also, don't forget to type CTRL Z at line 5 to exit program entry. Command ASM PAUSE.AAX initiates program assembly.

After program assembly, type:

A>LOAD PAUSE

Check directory to verify your PAUSE program.

3.18.44 AUTOTEST

The program in Figure 3-98 combines analyzer tests, prompting messages, and the PAUSE program.*

```
A>ed autotest.sub
    : *1
   1: ;
   2: ;  TO THE OPERATOR:  YOU'RE GOING TO PERFORM 3 TESTS.
   3: ;  IT'S IMPORTANT THAT YOU FOLLOW THE INSTRUCTIONS CAREFULLY.
   4: ;
   5: ;  STATE TEST:  AFTER READING THE INSTRUCTIONS BELOW, PRESS RETURN
   6:                 WHEN THE CURSOR FLASHES.  THIS WILL CALL THE STATE TEST
   7: ;
   8: ;  A. CONNECT THE A STATE PROBE TO THE A SIDE OF THE TEST CARD.
   9: ;  B. WHEN THE CONFIGURATION LIST APPEARS, PRESS THE COLLECT KEY.
  10: ;  C. AFTER THE TEST IS COMPLETE, PRESS THE CONFIG KEY FOLLOWED BY THE
  11:       ESC KEY TO RECEIVE INSTRUCTIONS FOR THE NEXT TEST.
  12:
  13: ;  REMEMBER, PRESS RETURN WHEN THE CURSOR FLASHES.
  14: PAUSE
  15: LARECALL STATE
  16: ;
  17: ;  TIMING TEST
  18: ;
  19: ;  A. CONNECT THE B TIMING PROBE TO THE B SIDE OF THE TEST CARD.
  20: ;  B. WHEN THE CONFIGURATION LIST APPEARS, PRESS THE COLLECT KEY.
  21: ;  C. AFTER THE TEST IS COMPLETE, PRESS THE CONFIG KEY FOLLOWED BY THE
  22:       ESC KEY TO RECEIVE INSTRUCTIONS FOR THE NEXT TEST.
  23: ;
  24: PAUSE
  25: LARECALL TIMING
  26: ;
  27: ;  WAVEFORM TEST (OPTIONAL)
  28: ;
  29: ;  A.  CONNECT THE SCOPE PROBE TO THE WF TESTPOINT ON THE TEST CARD.
  30: ;  B.  AFTER THE CONFIGURATION LIST APPEARS, PRESS THE COLLECT KEY.
  31: ;  C.  THIS COMPLETES THE TEST SERIES.
  32: PAUSE
  33: LARECALL WAVE
  34:
  35: ; *E
  36:
```

Figure 3-98. AUTOTEST Program

*If necessary, consult the CP/M Software Documentation Manual for editing procedures required to correct program entry errors.

Don't forget CTRL Z on line 34. Also, if you previously renamed this command, replace LARECALL with R.

After entering this program, execute by typing:

SUBMIT AUTOTEST (RET)

and follow instructions. The NPC-800D executes each line exactly as it was originally typed in. You are encouraged to use this simple example as a model for more comprehensive automatic tests.

NOTE

If automatic tests, without operator intervention are required, the GPIB controller capability of the NPC-800D can be used (see paragraph 3.19).

3.19 IEEE-488 CONTROL

3.19.1 IEEE-488 Interface Controller

In recent years, the need for automated test and measurement equipment that uses the IEEE-488 bus has escalated. Such applications range from research projects, which require extremely complex measurements, to production test, which requires the same test be performed repetitively, without deviation, from the prescribed process.

The IEEE-488 General Purpose Interface Bus (or GPIB) allows the user to configure a test system to include most types of test instruments. Because of its interface standardization, the GPIB controller permits instruments from different manufacturers to be readily connected.

A basic NPC-800D can be used in the "device" as a "listener" and/or "talker." With the computer/controller option installed, using CP/M and CBASIC, it can also function as a bus controller.

The command set has been designed to be accessed from any application program. It has not been restricted to a specific language (such as CBASIC). Therefore, GPIB control functions can be available from many CP/M-compatible higher-level languages . However, CBASIC is easy to use and quite satisfactory for most applications.

All descriptions of controller commands assume that the computer/controller option is installed, and that CBASIC is the program language.

Most interface characteristics are user-definable using the keyboard or an application program. However, using a switch on the processor board, some may be set to an initial default value.

3.19.2 IEEE-488 Parallel Interface Port

The Processor Board DIP Switch Settings options are shown below:

GPIB DEVICE ADDR
ON = 0 OFF = 1
(ADDR31 DEFAULTS to 30)
A0 = SWITCH 1
A0 = SWITCH 2
A2 = SWITCH
A3 = SWITCH 4
A4 = SWITCH 5

SWITCH 8
ON = 60 Hz
OFF = 50 Hz

TERMINATION SEQUENCE:
ALWAYS ON EOI

SW6	SW7	
ON	ON	EOI ONLY
ON	OFF	CR
OFF	ON	LF
OFF	OFF	CR,LF

3.19.3 Command Set Summary

The following command set summary provides an overview of available functions. The remainder of this section describes each command in detail.

3.19.4 ABORT GPIB

This command, which clears the interface, stops all transactions presently taking place on the bus and initializes the interface.

3.19.5 RESET

Performs reset function on each instrument—individually or universally.

3.19.6 REMOTE

Enables one or all instruments to respond to controller's commands.

3.19.7 LOCAL

This command, which is the opposite of REMOTE, returns one or all instruments to local, front-panel control.

3.19.8 TRIGGER

Used after an instrument has been set up to make a data collection. Typically, several instruments are set up in sequence. Then all are TRIGGERED simultaneously to make a data collection.

3.19.9 REQUEST

Asserts the Request For Service line, SRQ. Normally REQUEST is used when the NPC-800D is acting as a LISTENER/TALKER on the bus.

3.19.10 OUTPUT

Sends data to each instrument usually in the form of a string of characters interpreted by the instrument as set-up instructions.

3.19.11 ENTER

Opposite of OUTPUT, it instructs instrument to send data to the controller (data are usually the result of a specific test).

3.19.12 STATUS

Serially requests status of each instrument to determine whether it has completed the last instruction.

3.19.13 SET TIMEOUT

Changes maximum time to wait for a response on the bus.

3.19.14 LOCAL LOCKOUT

Used by controller to lock all devices under remote control and disable front-panel input. (LOCAL ALL command is used to defeat LOCAL LOCKOUT).

3.19.15 CONFIGURE

Used by NPC-800D to set up data transmission between devices other than the NPC-800D.

3.19.16 EOI STATUS

Used after a CONFIGURE command, it identifies end of data transmission between devices.

3.19.17 SENDBUS

A special command used to tailor controller output for custom applications.

3.19.18 TERM SEQ

Allows user flexibility in specifying data termination sequences (when used with subsequent OUTPUT or ENTER commands).

The above command set is used to perform most common functions required in a GPIB test system. The IEEE-488 standard interface connector, located on back panel of NPC-800D, allows easy interface to instruments being controlled.

3.19.19 Reference Documents

Refer to the following documents for an elaboration of material presented in following sections:

- ☐ CBASIC Language Manual
- ☐ TMS9914 GPIB Adaptor Data Manual
- ☐ ANSI/IEEE Std. 488-1978

3.19.20 Abbreviations

ATN	Attention
DAB	Data Byte
DCL	Device Clear
GET	Group Execute Trigger
GTL	Go to Local
IFC	Interface Clear
LA	Listen Address
LAG	Listen Address Group*
MA	My Address
MLA	My Listen Address
MTA	My Talk Address
SCG	Secondary Command Group
SDC	Selected Device Clear
SPD	Serial Poll Disable
SPE	Serial Poll Enable
SRQ	Service Request
STB	Status Byte
TA	Talk Address
TAG	Talk Address Group**
TLC	Talker/Listener/Controller
UNL	Unlisten
UNT	Untalk

* LAG is defined as LA SCG LA SCG
**TAG is defined as TA SCG, where XXX indicates to duplicate "XXX" 0 or more times

3.19.21 General Discussion

The GPIB command package allows the NPC-800D to be used as a GPIB system controller, or as a device on a bus with a different controller. The NPC-800D uses an 8085 microprocessor with a CP/M operating system, and a TMS9914 GPIB adaptor chip. The GPIB command package uses the TMS9914 to control and interface to the bus. Commands can be used directly from an 8085 assembler program, or from a higher level language, such as CBASIC (software interface to commands is very flexible, allowing easy implementation from a variety of other languages).

When using the NPC-800D as a controller, the application program should treat the internal logic analyzer as a "device on the bus," just as if it were an external instrument.

As a system controller, the NPC-800D can transfer data to and from devices, respond to a service request, and send these GPIB commands: Remote/Local Changes, Device Clear, Selected Device Clear, Group Execute Trigger and Serial Poll. Commands and data output can be sent to any combination of bus listeners. A complete secondary addressing capability is also available. As a bus device, the NPC-800D can request service, respond to a serial poll and transfer data across the bus when addressed by the controller. A bus status command can be executed at any time to get the complete NPC-800D interface and GPIB status.

3.19.22 Detailed GPIB Command Descriptions

This section provides a description of each of the GPIB commands including command references.

3.19.23 I/O Configuration Menu

The I/O menu is used to enable interface, set the bus address—and optionally—to define the data termination sequence.

3.19.24 To Call Menu

1. press CONFIG or RESET key, then
2. press I key.

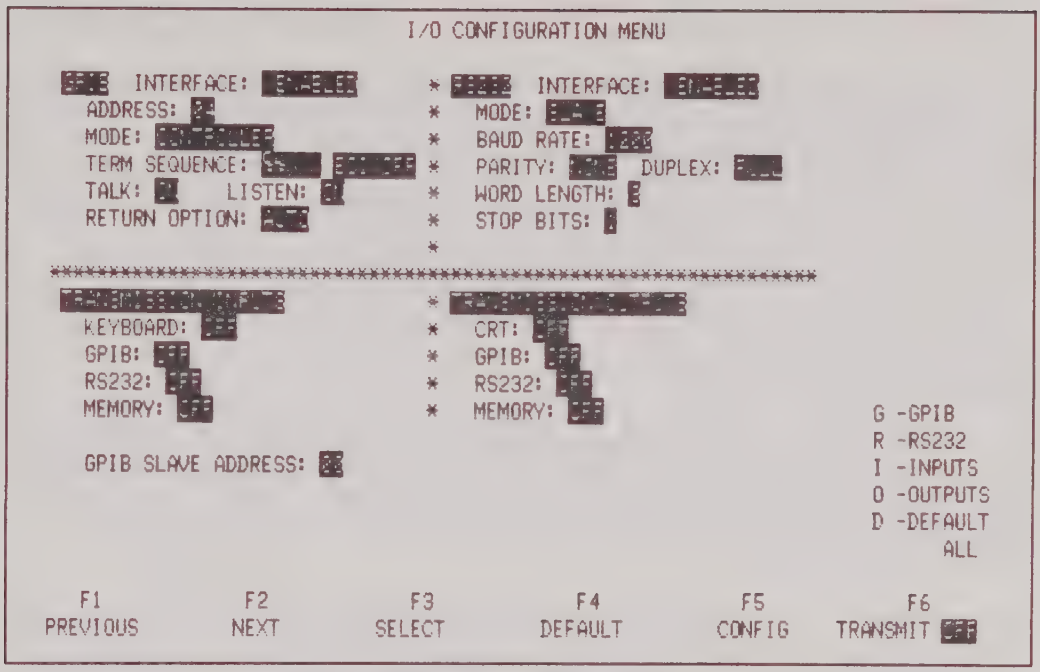

Figure 3-99. I/O Menu

3.19.25 Explanation Of Menu (GPIB Section)

3.19.26 Interface

Line 1: INTERFACE field defaults to ENABLED. This allows the NPC-800D to be either a CONTROLLER or DEVICE on the GPIB bus. Pressing SELECT key puts interface into a DISABLED state in which the NPC-800D is effectively disconnected from the bus.

3.19.27 Address

Line 2: ADDRESS field defines address of NPC-800D on GPIB bus. Pressing SELECT key increments address of device. Valid addresses are 00 through 30. Default address is 04.

3.19.28 Mode

Line 3: The MODE field determines if the NPC-800D is a DEVICE or CONTROLLER on the GPIB bus. Default condition is set by Section 2 on DIP switch located on processor board. The unit is a CONTROLLER if switch is in OFF position (switch is read during power up and when RESET key is pressed). Pressing SELECT key changes MODE to DEVICE.

Table 3-1. Power Up/Reset I/O Initialization

SWITCH 2	
ON	OFF
DEVICE	CONTROLLER

3.19.29 Termination Sequence

Line 4: TERMINATION SEQUENCE field defines end of data transmission. Flashing cursor is initially placed in ASCII character field. Pressing SELECT key changes sequence to CRLF (carriage return - line feed); CR alone; LF alone; or NULL (no ASCII characters). If NULL is selected, EOI ON automatically is selected and cannot be changed. If NULL is not selected, pressing NEXT key moves flashing cursor to EOI selection portion of TERMINATION SEQUENCE. Pressing SELECT key changes EOI to ON or OFF. If EOI ON is selected, EOI is sent out with last character of termination sequence previously selected or with last character of data if NULL was selected. Default states for the TERMINATION SEQUENCE field are CRLF and EOI OFF.

3.19.30 Talk Listen

Line 5: These fields, which determine whether NPC-800D is a TALKER, LISTENER, or both on GPIB bus, normally default to ON. With ON cursor flashing, press SELECT key to disable function and set field to OFF.

3.19.31 Return Option

Line 6: RETURN OPTION field defines the way the NPC-800D returns to the CP/M Calling Program from the ANALYZER mode. The field defaults to AUTO. Pressing SELECT key changes field from AUTO to AUTO/MAN, to MANUAL. In AUTO mode, the return to CP/M takes place immediately after command string has been executed by the analyzer. In MANUAL mode, return to CP/M takes place when R key is pressed (R key is not defined in this menu). In AUTO/MAN mode, a return to CP/M takes place immediately after command string has been executed by the analyzer; except when a data collection is being initiated by the command string. After data collection is completed, the return to CP/M is the same as described above for MANUAL mode.

3.19.32 Transmission Inputs

This section defines the source(s) of data that are sent to the interface or memory defined in the TRANSMISSION OUTPUTS section which follows.

3.19.33 Keyboard

Line 7: The KEYBOARD field normally defaults to OFF. The keyboard can only be used to configure and control the analyzer in the OFF state. With OFF cursor flashing, to transmit data to the interface(s) selected in the TRANSMISSION OUTPUTS section, press SELECT key (turns KEYBOARD field ON).

3.19.34 GPIB

Line 8: The GPIB field normally defaults to OFF. If INTERFACE field in GPIB section of menu is DISABLED, GPIB field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key turns this field ON and enables the NPC-800D to receive data from another device over the GPIB bus and to send data to the destination(s) selected in the TRANSMISSION OUTPUTS section (which follows).

3.19.35 RS-232 and Memory

Line 9: RS-232 field normally defaults to OFF. If INTERFACE field in RS-232 section of menu is DISABLED, RS-232 field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key turns this field ON and enables the NPC-800D to receive data from another device over the RS-232 interface and to send data to the destination(s) selected in the TRANSMISSION OUTPUTS section (which follows).

Line 10: MEMORY field normally defaults to OFF. If MODE field in GPIB section is set to DEVICE and mode field in RS-232 section is set to SLAVE, the field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key provides several combinations of memory data to be transmitted over the GPIB or RS-232 interfaces. With field flashing, pressing SELECT key allows you to select TIMING or STATE memory to be transmitted. Pressing NEXT key moves flashing cursor to SETUP field. With SETUP field flashing, pressing SELECT key allows you to select the memory type to be transmitted. The choices are SETUP, DATA, or AUX. Pressing DEFAULT key when either field is flashing sets both fields to OFF.

3.19.36 Transmission Outputs Section

3.19.37 CRT

Line 7: CRT field, which normally defaults to OFF, displays configuration menus and data collection displays in the OFF state. With OFF cursor flashing, pressing SELECT key turns CRT ON to display data received on the interface(s) selected in the TRANSMISSION INPUTS section.

3.19.38 GPIB

Line 8: GPIB field normally defaults to OFF. If INTERFACE field in GPIB section of menu is DISABLED, GPIB field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key turns this field ON and enables the NPC-800D to transmit data to another device over the GPIB bus. The data sent are from the source(s) selected in the TRANSMISSION INPUTS section.

3.19.39 RS-232

Line 9: RS-232 field normally defaults to OFF. If INTERFACE field in RS-232 section of menu is DISABLED, RS-232 field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key turns this field ON and enables NPC-800D to transmit data to another device over the RS-232 interface. The data sent are from the source(s) selected in the TRANSMISSION INPUTS section.

3.19.40 Memory

Line 10: MEMORY field normally defaults to OFF. If MODE field in GPIB section is set to DEVICE and MODE field in RS-232 section is set to SLAVE, the field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing the SELECT key provides several combinations of memory to receive data from another NPC-800D over the interface selected in the TRANSMISSION INPUTS section. With the field flashing, pressing SELECT key allows you to select TIMING OR STATE memory to receive data. Pressing NEXT key moves flashing cursor to SETUP field. With SETUP field flashing, pressing SELECT key allows you to select the memory type to receive data. Choices are SETUP, DATA, or AUX. Pressing DEFAULT key, when either field is flashing, sets both fields to OFF.

3.19.41 GPIB Slave Address

Line 12: GPIB SLAVE ADDRESS field is displayed only if MODE field in GPIB section is set to CONTROLLER. Pressing SELECT key increments the address. Valid addresses are 00 through 30. The field defines the GPIB address of another NPC-800D (or another device*) to which the data or memory block are sent, as defined in the TRANSMISSION INPUTS or OUTPUTS section.

3.19.42 Labels

Lines 11 to 15: These fields are labels to define direct entry key functions. Pressing G, R, I, or O moves flashing cursor to associated section of menu. Pressing D sets every field to its default state.

If MEMORY input or MEMORY output is selected, the TRANSMIT key initiates data transmission. The field will show TRANSMIT ON during transmission and changes back to TRANSMIT OFF upon transmission completion.

NOTE

Only one MEMORY (input or output) is allowed to be selected. The other MEMORY is forced to OFF.

*The format of some of transferred data is unique and only a NPC-800D can use it without translation. This field is not normally used.

3.19.43 Abort GPIB or INIT GPIB

This command will ABORT any pending bus transactions, put all devices in remote, and assert the NPC-800D as the active controller. Also, all necessary initialization for proper bus functioning is performed. If TALKER/LISTENER/CONTROLLER (TLC) mask specifies that the NPC-800D is not the system controller, only initialization in the NPC-800D will be performed; bus configuration remains unchanged.

Sequence

1. Reset TMS9914 bus controller chip
2. Save MAX-TIMEOUT in parameter area
*3. Set IFC
*4. Wait 100 microseconds
*5. Set IFC
*6. Set REN

*These steps are performed only if TLC mask = XX1

3.19.44 Reset

The RESET command places a device (or devices) into a known initial state. Two different RESETS are implemented. If an address list is specified, an SDC command is sent to each device in the list. Otherwise, a DCL command is sent to all devices. Whether a device implements a DCL or SDC, and also implements the actual effects of the command, depends on the particular instrument used. Only the active controller can issue a RESET.

Sequence For No Address List

1. Set ATN
2. Send DCL

Sequence For Address Specified

1. Set ATN
2. Send MTA
3. Send UNL
4. Send LAG
5. Send SDC

3.19.45 Remote

Sent by the active controller, the REMOTE command places one or more devices under GPIB control. It can be issued to all devices or to any specified device or group of devices. Normally, the REMOTE to all devices is not necessary, because it is also executed during the ABORT GPIB command. A device (or devices) can be removed from REMOTE state with a LOCAL command, then later toggled back to REMOTE.

Sequence For REMOTE-All Devices

1. Set REN

Sequence For REMOTE Device

1. Set REN
2. Set ATN
3. Send MTA
4. Send UNL
5. Send LAG

NOTE

Actual state of a device on the bus when in REMOTE is device dependent.

3.19.46 Local

LOCAL command is used to remove a device from GPIB control and return it to its "normal" front-panel operation. This command may be issued to all devices or to any subset of devices. LOCAL command has no effect if a LOCAL LOCKOUT has been issued by a controller and not cleared.

Normally LOCAL command is sent by the active controller. However, two special cases are permitted when the NPC-800D is not the active controller. If no address is specified, the NPC-800D is set to the LOCAL state, independent of the active controller. If the NPC-800D is not the active controller and its own address is specified, it will "LOCK" itself in the LOCAL state, so that the active controller has no access. Sending a LOCAL command again with no address will "UNLOCK" the NPC-800D.

Sequence For All Devices

1. Set REN

Sequence For A Device

1. Set ATN
2. Send MTA
3. Send UNL
4. Send LAG
5. Send GTL

3.19.47 Trigger

TRIGGER command is sent by the active controller to initiate a device function (for example, take DMM reading and send burst of pulses from pulse generator). TRIGGER command is sent only to those addresses specified and to all devices simultaneously; however, internal device delays should be considered for proper operation.

Sequence for TRIGGER Device(s)

1. Set ATN
2. Send MTA
3. Send UNL
4. Send LAG
5. Send GET

3.19.48 Request

REQUEST command is used to set the status byte that the active controller reads from MA during a serial poll. If BIT 6 of the status byte is set, a service request is sent to the controller. REQUEST has no function when in active controller state, but status is set when this state is exited.

Sequence

1. Set STB
*2. Set SRQ
*3. After active controller executes a serial poll, set SRQ.

*Only when BIT 6 = 1

3.19.49 Output

When in active controller state, OUTPUT command transfers DATA to all devices specified in the address list. When in TALKER-only state, data are transferred to any devices that have been set to listen by the active controller. In this example, the NPC-800D is not the initiating device, and only outputs data after it is requested. Data string length is 0 to 65,535 characters (0 to 255 from CBASIC).

Sequence

1. Set ATN
2. Send MTA
3. Send UNL
4. Send LAG
5. Set ATN
6. Send DAB
7. Repeat 6 for additional characters
8. Send TERMINATION SEQUENCE

Sequence For TALKER-Only

1. Send DAB
2. Repeat 1 for additional characters
3. Send TERMINATION SEQUENCE

3.19.50 Enter

When in active controller state, ENTER command transfers data from device specified to the NPC-800D. When in LISTENER-only state, data are transferred from TALKER to NPC-800D. Data string length is 0 to 65,535 characters (0 to 255 from CBASIC).

Sequence

*1. Set ATN
*2. Send UNL
*3. Send MLA
*4. Send TAG
*5. Set ATN
6. Enter DAB
7. Repeat Step 6 until TERMINATION SEQUENCE is satisfied.
*8. Set ATN
*9. Send UNT

*Used only in active controller mode.

If in LISTENER-only state, it is user's responsibility, using STATUS command, to first determine that data are being transferred to the NPC-800D.

3.19.51 Status

There are three different STATUS command functions. The first can be executed at any time using address = "B" (controller or noncontroller). This command returns MA for NPC-800D and TALKER/LISTENER/CONTROLLER status (active, idle, or not allowed for each function). Also, the occurrence of any of the following bus commands is reported:

GET
DCL
SDC
MA
UNIDENTIFIED COMMAND
HANDSHAKE ERROR
IFC
SRQ

STATUS command's second form is implemented by specifying the address of one GPIB device. This returns device STATUS BYTE, which occurs after a SERIAL POLL.

The third form of the STATUS command is implemented by not specifying an address. This causes a serial poll of all bus addresses. The return data are the status of each bus address (active, inactive, or service required).

Sequence For Address

1. Set ATN
2. Send UNL
3. Send MLA
4. Send TA
5. Send SPE
6. Set ATN
7. Receive STB
8. Set ATN
9. Send SPD
10. Send UNT

Sequence For "No" Addresses

1. Set ATN
2. Send UNL
3. Send MLA
4. Send SPE
5. Send TA(1)
6. Set ATN
7. Receive DAB
8. Set ATN
9. Repeat 5 thru 8 for TA(2) thru TA(30)
10. Send SPD
11. Send UNT

3.19.52 Set Timeout

SET TIMEOUT command can be issued at any time to change the maximum time (in milliseconds) to wait for a response on the bus. The ABORT GPIB command resets max time to a default time specified in the primitives.

3.19.53 Local Lockout

LOCAL LOCKOUT (LLO) is a GPIB universal command. It can be issued by the active controller to lock all devices under GPIB remote control and disable front-panel local control (if any). A LOCAL ALL command must be used to defeat the LOCAL LOCKOUT.

Sequence

1. Set ATN
2. Send LLO

3.19.54 Configure

CONFIGURE command can be used when NPC-800D is active controller to set up GPIB for data transmission between devices (other than NPC-800D). One TALKER and any number of LISTENERS can be specified. After bus is configured, ATN is set false to allow TALKER to begin transmitting data. EOI STATUS command can be used to look for an occurrence of EOI (signifies that data transmission has been completed).

Sequence

1. Set ATN
2. Send UNL
3. Send LAG
4. Send TAG
5. Set ATN

3.19.55 EOI Status

EOI STATUS command is a special-purpose command (designed to be used after a CONFIGURE) (indicates end of data transmission between devices).

3.19.56 SENDBUS

SENDBUS command allows the user to tailor controller output for a special application. Any sequence of universal commands, addressable commands, or data can be specified—up to a maximum of 65,535 bytes (255 bytes for CBASIC).

3.19.57 TERM SEQ

TERM SEQ command allows flexible data termination sequences to be used in any subsequent OUTPUT or ENTER command. Several options are available:

1. Terminate output and enter with CR-LF.

2. Output—Same as 1, but with EOI true for LF.
   Enter—Terminate on EOI.

3. Output—Force EOI on last data byte.
   Enter—Terminate on EOI.

4. Same as 1, but any termination sequence (up to 5 bytes) can be specified in place of CR-LF.

5. Same as 4, but EOI is forced on last byte of specified termination sequence.

3.19.58 GPIB Command Implementation Via CBASIC

Following is a description of how to use each GPIB command from a CBASIC PROGRAM. To use GPIB from CBASIC, the file GPIB.BAS must be inserted (ahead of any GPIB command references) in a CBASIC PROGRAM (before compilation). This is done using the EDITOR or by using: % INCLUDE GPIB.

This CBASIC directive includes GPIB.BAS in the compilation that directly follows its placement. This file contains CBASIC source code which defines GPIB FUNCTION definitions. If necessary, to conserve memory space, any of these function definitions, which are not needed by a user program, can be deleted.

In the GPIB, function definition headings are several variables that the user may wish to change:

1. start address of GPIB commands in PROM, or
2. start address of 32 byte RAM parameter & stack area.

For each GPIB command, a CBASIC statement format is defined. This is the recommended format, it can be modified for a particular application. Any valid CBASIC statement can be used if the function call is intact.

3.19.59 ABORT GPIB Or INIT GPIB

Statement Format (type on one line):

STMT NUMBER	GPIB.RET% = FN.ABORT.GPIB% or GPIB.RET% = FN.INIT.GPIB%
Parameters:	None
Options:	None. (However, the effects of the command depends on whether NPC-800D is system controller).
Purpose:	1. Initialization 2. Abort pending bus transactions (only when system controller) 3. Take control of bus (only when system controller)
Return Code	GPIB.RET% = 0 NPC-800D is active system controller GPIB.RET% = 1 NPC-800D is device

NOTE

To assure proper initialization, INIT GPIB command must be used prior to any other GPIB command in a program

3.19.60 RESET

Statement Format (type on one line):

STMT NUMBER GPIB.RET% = FN.RESET%(ADDRESS LIST)

Parameters:

ADDRESS LIST is an ASCII string which specifies which bus devices are to be RESET (see paragraph 3.19.74 for Data Format).

Options:

1. ADDRESS LIST = "valid paragraph 3.19.74 format" data. This sends a Selected Device CLEAR (SDC) to all bus devices specified.

2. ADDRESS LIST = NULL. This sends a DCL to all bus devices.

Purpose:

1. Send a SDC to each address specified in ADDRESS LIST, or
2. Send a DCL to all devices on GPIB.

Return Code:

GPIB.RET% equals 0 if command is executed properly; otherwise one or more error bits are set as follows:

ERROR DEFINITION

Bit 0 — NPC-800D is not active controller
Bit 1 — Not used
Bit 2 — Timeout
Bit 3 — Invalid ADDRESS LIST format

NOTE

RESET command does not reset GPIB. Actual effect of command (if any) depends on its implementation in bus devices.

3.19.61 REMOTE

Statement Format (type on one line):

STMT NUMBER GPIB.RET% = FN.REMOTE%
(ADDRESS LIST)

Parameters:

ADDRESS LIST is an ASCII string which specifies which bus devices are to be set to GPIB control (see paragraph 3.19.74 for data format).

Options:

1. ADDRESS LIST = "valid paragraph 3.19.74 format" data. Used when NPC-800D is active controller. Sets specific bus devices back to GPIB bus control after a LOCAL command with Option 1 has been executed.

2. ADDRESS LIST = NULL. Used when NPC-800D is active controller. Re-asserts REN LINE, after a LOCAL (with Option 2) has been executed.

Purpose:

To set bus or bus devices back to GPIB control after a LOCAL command has been executed.

Return Code:

GPIB.RET% equals 0 if command is executed properly, otherwise, one or more error bits are set, defined as follows:

ERROR DEFINITION

Bit 0 — NPC-800D is not active controller
Bit 1 — Not used
Bit 2 — Timeout
Bit 3 — Invalid ADDRESS LIST format

NOTE

A REMOTE command with Option 2 does not place devices in REMOTE if they have been set to LOCAL using Option 1. They must be set back to remote using Option 1 format.

3.19.62 LOCAL

Statement Format (type on one line):

STMT NUMBER GPIB.RET% = FN.LOCAL%
(ADDRESS LIST)

Parameters:

ADDRESS LIST is an ASCII string that specifies which bus devices are to be set to LOCAL (front panel) operation (see psragraph 3.19.74 for data format).

Options:

1. ADDRESS LIST = "valid paragraph 3.19.74 format" data. Used when NPC-800D is active controller, command specifies devices to LOCAL.

2. ADDRESS LIST = NULL. When NPC-800D is active controller, a DCL is sent to all devices. If NPC-800D is not active controller, it is set to LOCAL.

3. ADDRESS LIST = "L". Used when NPC-800D is not active controller. This option locks NPC-800D in local until a LOCAL command using Option 2 is executed.

Purpose:

Remove a device (or devices) from GPIB bus control and return it to "front panel" operation.

Return Code:

GPIB.RET% equals 0 if command is executed properly, otherwise one or more error bits are set, defined as follows:

ERROR DEFINITION

Bit 0 — Improper controller state
Bit 1 — Not used
Bit 2 — Timeout
Bit 3 — Invalid ADDRESS LIST format

3.19.63 TRIGGER

Statement Format (type on one line):

STMT NUMBER GPIB.RET% = FN.TRIGGER%
(ADDRESS LIST)

Parameters:

ADDRESS LIST is an ASCII string specifying which bus devices are to receive Group Execute Trigger (GET) command (see paragraph 3.19.74 for data format).

Options: None

Purpose:

To send a GET command (simultaneously) to all devices specified in address list.

Return Code:

GPIB.RET% equals 0 if command is executed properly: otherwise one or more error bits are set as follows:

ERROR DEFINITION

Bit 0 — NPC-800D is not active controller
Bit 1 — Not used
Bit 2 — Timout
Bit 3 — Invalid ADDRESS LIST format

NOTE

When using TRIGGER command to trigger multiple devices simultaneously, it is important to consider response times of instruments as they can vary widely (from millisecond to second).

3.19.64 REQUEST

Statement Format (type on one line):

STMT NUMBER GPIB.RET% = FN.REQUEST%
(STATUS)

Parameters:

STATUS is an INTEGER that is sent (LSB only) on the GPIB as a response to a serial poll by the active controller.

Options:

Bit 6 of STATUS is used to request service from the active controller. If it is set, an SRQ is generated. The remaining seven bits can be defined by the user.

Purpose:

1. Load GPIB status byte
2. Optionally generate an SRQ

Return Code: Bit 2 Timeout

NOTE

1. *ABORT.GPIB clears status byte.*
2. *RESET to MA clears status byte.*
3. *REQUEST can be executed when NPC-800D is active controller and status byte is loaded, but no other action will take place.*

3.19.65 OUTPUT

Statement Format (type on one line):

STMT NUMBER GPIB.RET% = FN.OUTPUT%
(ADDRESS LIST, DATA)

Parameters:

DATA, an ASCII string, is sent to all bus devices that are set to listen. It can be any valid CBASIC string expression (0 to 255 characters).

ADDRESS LIST, an ASCII string, specifies bus devices which are to listen to data (see paragraph 3.19.74 for data format).

Options:

1. ADDRESS LIST = "valid paragraph 3.19.74 format" data. Used when NPC-800D is active controller and specifies bus LISTENERS.

2. ADDRESS LIST = NULL. Used when NPC-800D is not active controller.

Purpose:

Transmit ASCII data from NPC-800D to other bus devices

Return Code:

GPIB.RET% equals 0 if command is executed properly, otherwise one or more error bits are set, defined as follows:

ERROR DEFINITION

Bit 0 — Improper controller state
Bit 1 — In device mode and not addressed to talk
Bit 2 — Timeout
Bit 3 — Invalid ADDRESS LIST format
Bit 4 — NPC-800D is not a TALKER

NOTE

To signify end of transmission, TERMINATION SEQUENCE is transmitted immediately following data.

3.19.66 ENTER

Statement Format (type on one line):

STMT NUMBER DATA$ = FN.ENTER$(ADDRESS)

Parameters:

DATA, a string variable, contains ASCII data entered from a device (after execution).

ADDRESS, an ASCII string, specifies address of device which is to talk on bus (see paragraph 3.19.74 for data format).

Options:

1. ADDRESS LIST = "valid paragraph 3.19.74 format" data. Used when NPC-800D is active controller.

2. ADDRESS LIST = NULL. Used when NPC-800D is not active controller or for continuing the entering of long data strings.

Purpose: To transmit data from another device on GPIB to NPC-800D.

Return Code

CNTRL REG% equals 0 if command is executed properly, otherwise one or more error bits are set as follows:

ERROR DEFINITION

Bit 0 — Improper controller state
Bit 1 — In device mode and not addressed to listen
Bit 2 — Timeout
Bit 3 — Invalid (address) format
Bit 4 — NEW MODE is not a LISTENER
Bit 5 — Input data has been truncated

NOTE

1. Data are entered from TALKING device until termination sequence is encountered. However, only first 255 bytes are saved in data.
2. To continue entering data when truncated, use ADDRESS = NULL mode repeatedly until data transfer is complete (DMA.SET% = 0).

STATUS

Statement Format (one or more lines)

STATUS NUMERIC DATA% = PN STATUS(ADDRESS)

Description

STATUS is a string variable, contains the status of the device (or devices) specified by ADDRESS.

ADDRESS is a STR string specifies address of device whose status is required (see paragraph 5.3.2 for data format).

Discussion

STATUS(ADDRESS) - reads parallel poll response (PPR) of device specified by address (see paragraph 5.3.2).

STATUS(NULL) - reads status of all bus addresses (present, not present, or service requested).

STATUS(ANY) - returns first device found requesting service (PPR, SRQ) bus address (MLA) and PPR mask.

Purpose

1. Perform serial poll of specific device and return its status byte, or
2. Get configuration status (what devices are present, who is requesting service), or
3. Get PPR mask, SRQ, MLA of PPR user.

Return Code:

GPIB.RET% equals 0 if command is executed properly; otherwise, one or more error bits are set as follows:

ERROR DEFINITION

Bit 0 — Not active controller
Bit 1 — Not used
Bit 2 — Timeout
Bit 3 — Invalid address format
Bit 15-8 — Device status byte

DEFINITION FOR BUS STATUS

Bit 0 — REN is true
Bit 1 — IFC is true
Bit 2 — SRQ is true
Bit 3 — EOI is true
Bit 4 — NRFD is true
Bit 5 — NDAC is true
Bit 6 — DAV is true
Bit 7 — ATN is true
Bit 8 — IFC has occurred
Bit 9 — SRQ has occurred
Bit 10 — MA has occurred
Bit 11 — DCL has occurred
Bit 12 — Not used
Bit 13 — Unidentified
Bit 14 — Incomplete handshake has occurred
Bit 15 — GET has occurred

3.19.68 SET TIMEOUT

Statement Format:

STMT NUMBER GPIB.RET% = FN.SET.TIMEOUT%(TIME)

Parameters:

TIME is the desired maximum time (binary) to wait for all devices to respond to bus transactions (in milliseconds).

Options: None

Purpose:

Used to initially specify the maximum time in a program, or to temporarily change the time to allow for an extremely slow device response.

Return Code: Not used

NOTE

ABORT.GPIB (or INIT.GPIB) command resets maximum timeout to a default value; specified in primitives of five seconds.

3.19.69 LOCAL LOCKOUT

Statement Format:

STMT NUMBER GPIB.RET% = FN.LOCAL.LOCKOUT%

Parameters: None

Options: None

Purpose: To enable local lockout feature of GPIB (a universal command).

Return Code:

GPIB.RET% equals 0 if command is executed properly; otherwise one or more error bits are set as follows:

ERROR DEFINITION

Bit 0 — NPC-800D is not active controller
Bit 1 — Not used
Bit 2 — Timeout

NOTE

Setting REN false (that is, LOCAL with null address list) disables LOCAL LOCKOUT state.

3.19.70 CONFIGURE

Statement Format (Type on one line):

STMT NUMBER GPIB.RET% = FN.CONFIGURE(TALK ADDRESS, LISTEN ADDRESS LIST)

Parameters:

TALK ADDRESS, an ASCII string, specifies data output device (see format for "ADDRESS" in paragraph 3.19.74).

LISTEN ADDRESS LIST, an ASCII string, specifies which bus devices are to receive data from talking device (see format for ADDRESS LIST in paragraph 3.19.74).

Options: None

Purpose:

To configure GPIB to transfer data between devices on the bus without having the controller handle data, thus optimizing transfer rate and freeing controller for other duties.

Return Code:

GPIB.RET% equals 0 if command is executed properly; otherwise one or more error bits are set as follows:

	ERROR DEFINITION
Bit 0 —	Not active controller
Bit 1 —	Not used
Bit 2 —	Timeout
Bit 3 —	Invalid ADDRESS format

NOTE

After configuring GPIB TALKER and LISTENERS, ATN is set false, which initiates data transfer. EOI STATUS command should then be used to detect end of this data transfer (if necessary).

3.19.71 EOI STATUS

Statement Format (Type on one line):

STMT NUMBER GPIB.RET% = FN.EOI.STATUS%

Parameters: None

Options: None

Purpose: To detect end of data transmission between devices setup by a CONFIGURE statement.

Return Code:

GPIB.RET% equals 0 if EOI has not occurred, and 8 if it has occurred.

NOTE

This command should only be used after a CONFIGURE has been executed. If executed at other times, GPIB interface could possibly be left in an unknown state.

3.19.72 SENDBUS

Statement Format (Type on one line):

STMT NUMBER GPIB.RET% + FN.SEND.BUS% (COMMAND/DATA STRING)

Parameters:

COMMAND/DATA STRING contains the combined command and data to be output by the controller. Two characters are used to control output type (command or data). A colon signifies the switch to COMMAND output (ATN true) and a semicolon signifies the switch to DATA output (ATN false). For example; the string ":?(;WAKEUP:6*;START" would have this effect:

:	set ATN
?	send UNL
(	send LISTEN ADDRESS 8
;	set ATN false
WAKE UP	data sent to address 8
:	set ATN
6*	send listen address 22 and 10
;	set ATN false
START	data sent to address 8, 10 & 22

Refer to ASCII & GPIB Code, Chart in Appendix

Options: None

Purpose:

Generation of flexible command/data output structures when NPC-800D is the controller.

Return Code:

GPIB.RET% equals 0 if command is executed correctly; otherwise one or more error bits are set as follows:

	ERROR DEFINITION
Bit 0 —	Not active controller
Bit 1 —	Not used
Bit 2 —	Timeout
Bit 3 —	Not used
Bit 4 —	NPC-800D is not a TALKER

3.19.73 TERMINATION SEQUENCE

Statement Format:

STMT NUMBER GPIB.RET% = FN.TERM.SEQ%(DATA)

Parameters:

DATA contains desired ASCII sequence to signify end of data string on OUTPUT and ENTER.

Options:

1. DATA = NULL (CR/LF is used).
2. DATA = "E" (EOI is forced on last data byte).
3. First character of DATA = ":" forces EOI on last byte of termination sequence.

Purpose: Definition of alternate data terminators for OUTPUT and ENTER.

Return Code: Not used.

NOTE

ABORT.GPIB (or INIT.GPIB) resets termination sequence to CR/LF.

3.19.74 Address/Data Formats For CBASIC

FUNCTION	C*	D*	Statement Format
Initialize	X	X	GPIB.RET% = FN. ABORT GPIB%
Abort/Take Control	X		GPIB.RET% = FN.ABORT.GPIB%
Device Clear	X		GPIB.RET% = FN.RESET%("")
Selected Device Clear	X		GPIB.RET% = FN.RESET%(ADDRESS.LIST$)
Go To Local-All	X		GPIB.RET% = FN.LOCAL%("")
Go To Local-Device	X		GPIB.RET% = FN.LOCAL%(ADDRESS.LIST$)
Set NPC-800D To Local		X	GPIB.RET% = FN.LOCAL%("")
Lock NPC-800D in Local		X	GPIB.RET% = FN.LOCAL%("L")
Remote Enable	X		GPIB.RET% = FN.REMOTE%("")
Set Device to Remote	X		GPIB.RET% = FN.REMOTE%(ADDRESS.LIST$)
Device Status	X		DUMMY.VARIABLE$ = FN.STATUS$(ADDRESS)
Configuration Status	X		STATUS.VARIABLE$ = FN.STATUS$("")
Bus Status	X	X	STATUS.VARIABLE$ = FN.STATUS$("B")
Group Execute Trigger	X		GPIB.RET% = FN.TRIGGER%(ADDRESS.LIST$)
Request Service		X	GPIB.RET% = FN.REQUEST%(STATUS.BYTE%)
Output Data	X		GPIB.RET% = FN.OUTPUT% (ADDRESS.LIST$,DATA$)
Output Data		X	GPIB.RET% = FN.OUTPUT%("",DATA$)
Input Data	X		DATA.VARIABLE $ = FN.ENTER%(ADDRESS$)
Input Data	X	X	DATA.VARIABLE $ = FN.ENTER%("")
Local Lockout	X		GPIB.RET% = FN.LOCAL.LOCKOUT%
Set Timeout	X	X	DUMMY% = FN.SET.TIMEOUT%(TIME%)
Configure	X		GPIB.RET% = FN.CONFIGURE%(ADDRESS$, ADDRESS.LIST$)
EOI Status	X		GPIB.RET% = FN.EOI.STATUS%
Sendbus	X		GPIB.RET% = FN.SEND.BUS% (COMMAND.DATA$)
Termination Sequence	X	X	GPIB.RET% = FN.TERM.SEQ%(TERM$)

*C - CONTROLLER mode
*D - DEVICE mode

3.19.75 ADDRESS$

The primary GPIB bus address (range 00-30) of one bus device can be followed by any number of secondary commands (range 00-31). A decimal point is used to separate each address/command.

Examples: 25
12.15
04.31.09

3.19.76 ADDRESS.LIST$

Up to 15 GPIB devices can be specified, using the format for address$. Device addresses are separated by a comma.

Examples: 12.15,04.31.09
23
10,15,20,25

3.19.77 DATA$

Output data string to device(s). Can be any valid ASCII expression.

3.19.78 DATA.VARIABLE$

Name of ASCII variable which contain data after an ENTER.

3.19.79 STATUS.BYTE%

A byte which is returned to the controller in response to a serial poll. Setting bit 6 sets SRQ to request service from the controller.

3.19.80 STATUS.VARIABLES

For FN.Status$("A?") this variable is 31 characters long, each character corresponding to a bus address, 0-30, where:

N = No device present
P = Device present
S = Device has requested service

For FN.Status$("B") the character positions are defined as follows:

1. My address (in binary)
2. Address status (used primarily when NPC-800D is bus device)

BIT: 0-TADS or TACS (addressed to talk)
1-LADS or LACS (addressed to listen)
4-ATN is true
5-LLO is on
6-In remote state

3. TALK/LISTEN/CONTROL Status

   BIT: 0-Device mode
   1-Active/System controller
   2-Controller enabled
   3-Listen enabled
   4-Talk enabled

3.19.81 CBASIC Reserved Identifiers

The following Reserved Variable Identifiers should not be used in application programs because they are used in the GPIB software interface :

FN.ABORT.GPIB%
FN.CALL.GPIB%
FN.CONFIGURE%
FN.ENTER$ FN.EOI.STATUS%
FN.GPIB.ASM%
FN.INIT.GPIB%
FN.LOCAL%
FN.LOCAL.LOCKOUT%
FN.MAXGPIB.TIME%
FN.OUTPUT%
FN.PARM.LOC%
FN.REMOTE%
FN.REQUEST%
FN.RESET%
FN.SEND.BUS%
FN.SET.TIMEOUT%
FN.STATUS$ FN.TERM.SEQ%
FN.TRIGGER%

3.19.82 Direct Use of GPIB Primitives

1. Before calling a command, these locations must first be loaded with appropriate data:

   E000 LSB of starting address of GPIB ADDRESS LIST
   E001 MSB of starting address of GPIB ADDRESS LIST
   E002 LSB of starting address of DATA string
   E003 MSB of starting address of DATA string
   E006 Command Branch Index
   E007 Command Control Word

2. Execute a call to location F842 HEX.

3. After execution, return code is in locations E008 (LSB) and E009 (MSB).

4. Only the stack is preserved, registers are destroyed.

NOTE

See paragraph 3.19.47 for data formats of each parameter in 1, above. For the REQUEST command, the binary data is passed in place of the DATA string address.

3.19.83 Address/Data Formats For Assembler Primitives

ADDRESS:

First location is length of ADDRESS LIST (1-255). Each subsequent location contains a TALK, LISTEN or secondary address.

3.19.84 BIT

4-0 Binary Device Address
6-5 Address Type: 01 = LISTEN
10 = TALK
11 = SECONDARY

All commands can use any combination of LISTEN and secondary addresses, except ENTER and STATUS, which can have one TALK address and any number of secondary addresses.

3.19.85 DATA (Bus Status)

The first location which contains string length, is always three. The next location contains MA, in binary. The third location contains MA status. This location is primarily of interest when the NPC-800D is a bus device. The fourth location contains the system mode.

BUS STATUS
Bit 0 — Addressed to TALK (TADS or TACS)
Bit 1 — Addressed to LISTEN (LADS or LACS)
Bit 4 — ATN is true
Bit 5 — LLO is active
Bit 6 — In remote state

SYSTEM MODE
Bit 0 — Device
Bit 1 — Controller
Bit 4-2 — TLC Mask

3.19.86 Command Branch Index

A binary number from command-selected index (from Branch Table).

0 = Abort/Init
1 = Selected Device Clear (alternate command is Device Clear)
2 = Go To Local (alternate command sets REN false)
3 = Local-Lock
4 = Go To Remote (alternate command sets REN true)
5 = Device Status
6 = Bus Status
7 = Trigger
8 = Request
9 = Output
10 = Enter
11 = Local Lockout
12 = Configure
13 = Sendbus
14 = EOI Status
15 = Set Termination Sequence

3.19.87 Command Control Byte

ERROR DEFINITION

Bit 0 — 0 = Byte mode; 1 = Word mode
Bit 1 — 0 = Listen Address: 1 = Talk Address
Bit 2 — Address conversion required
Bit 3 — Alternate command select (equivalent to NULL Address mode of CBASIC command description)
Bit 4-5 — Required controller status:
00 = Don't Care
01 = Must be device
10 = Must be controller
11 = Must be controller if alternate command is not selected
Bit 6 — Must be LISTENER
Bit 7 — Must be TALKER

3.19.88 Return Code

ERROR DEFINITIONS

Bit 0 — Incorrect controller status
Bit 1 — NPC-800D is device and not addressed to TALK/LISTEN
Bit 2 — Timeout
Bit 3 — Not used
Bit 4 — Not a TALKER/LISTENER
Bit 5 — Input data have been truncated to length of data string

DEFINITION FOR BUS STATUS

Bit 0 — REN is true
Bit 1 — IFC is true
Bit 2 — SRQ is true
Bit 3 — EOI is true
Bit 4 — NRFD is true
Bit 5 — NDAC is true
Bit 6 — DAV is true
Bit 7 — ATN is true
Bit 8 — IFC has occurred
Bit 9 — SRW has occurred
Bit 10 — MA has occurred
Bit 11 — DCL has occurred
Bit 12 — Not used
Bit 13 — Unidentified command has occurred
Bit 14 — Incomplete handshake has occurred
Bit 15 — GET has occurred

EXCEPTIONS

FOR ABORT.GPIB: 0 = Controller
1 = Device

FOR EOI STATUS: 0 = EOI has not occurred
8 = EOI has occurred

FOR DEVICE STATUS: Device status byte (STB) is in MSB of return code.

3.19.89 Level of GPIB Implementation

The following table provides a summary of the implementation level of those functions described in document: ANSI/IEEE Std. 488-1978.

Identification	Description	Notes
SH1	Source Handshake	
AH1	Acceptor Handshake	
T6	Talker	TO when TALK is off
TEO	Extender Talker	
L4	Listener	LO when LISTEN is off
LEO	Extender Listener	
SR1	Service Request	
RL1	Remote Local	
PPO	Parallel Poll	
DCO	Device Clear	
DTO	Device Trigger	
C1	Controller	CO when DEVICE
C2	Controller	CO when DEVICE
C3	Controller	CO when DEVICE
C4	Controller	Co when DEVICE
C27	Controller	CO when DEVICE

3.19.90 Command Formats

1. MENU COMMANDS

GPIB commands to setup the NPC-800D generally follow the same format and sequence used when commanding the NPC-800D from the keyboard. ASCII characters are used for all commands. The actual definition of each ASCII character depends on menu that is currently being displayed. See paragrah 3.20.31 for soft-key definitions and Table 3-2 for command formats and field definitions.

2. BUS COMMANDS

In addition to MENU COMMANDS, a set of BUS COMMANDS is available to enhance the external control features of the NPC-800D (see Table 3-3 for a summary of these commands).

3. IEEE-488 (GPIB)

For GPIB operation, command strings are limited to 80 bytes. All command strings must end in the correct termination sequence (which is programmable in the NPC-800D). Only one BUS COMMAND is allowed in a command string, and it must be the last one specified. For burst commands, data must follow command string termination sequence. There are no limits to length of data portion of a burst command.

3.19.91 Commands That Return Data

Table 3-3 contains a summary of all commands which return data from the analyzer. Some commands are returned as several strings of ASCII characters on the IEEE-488 bus; each terminated with a Carriage Return/Line Feed. Data are ASCII-encoded HEX: therefore the number of characters transmitted will be twice the number of data bytes shown in Table 3-4.

Table 3-2. Command Formats and Field Definitions

Format Number	Format	Field Definitions
1	A CRLF	Keyboard Commands
2	A CRLF	Bus Commands
3	A HXHX CRLF	Address
4	A HXHX DDDD CRLF	Number of Hex Pairs Address
5	A HXHX HX CRLF	Data Address
6	A CRLF AAA... CRLF	ASCII Data

NOTE

For the NPC-800D, CRLF is the GPIB termination sequence. Each time an FN.OUTPUT function is executed from CBASIC, the termination sequence is transmitted automatically by the NPC-800D.

HX = Hexadecimal Pair (e.g., 0F)
D = Decimal Digit
A = ASCII Character

Table 3-3. NPC-800D Command List (Other than Keyboard Commands)

Command	Description	Format Number
>0	Initialize All	2
>1	Initialize Logic Analyzer (excluding I/O menu)	2
>2	Lock Keyboard	2
>3	Unlock Keyboard	2
>4	Clear CRT	2
>5	CONFIGURATION LIST	2
>6	CONFIGURATION LIST-SELECT 48 CHANNEL STATE	2
>7	Not Used	2
>8	Not Used	2
>9	Collect	2
>A	Read State Setup	*6
>B	Read State Data to Aux Memory	*6
>C	Same as above	*6
>D	Read Timing Setup	*6
>E	Read Timing Data to Aux Memory	*6
>F	Same as above	*6
>G	Dump State Setup	2
>H	Dump State Data	2
>I	Dump State Aux	2
>J	Dump Timing Setup	2
>K	Dump Timing Data	2
>L	Dump Timing Aux	2
>M	Dump Collection Status	2
>N	Dump Signatures	2
>P	Dump Collection Variables	2
>Q	Dump State Probe A Data	4
>R	Dump State Probe B Data	4
>S	Dump State Probe C Data	4
>T	Dump Timing Data	4
>U	Dump Screen to RS-232 Device	2
>V	Dump Byte from Memory to Output Device	3
>W	Write Byte to Memory from Input Device	5
>X	Set CRT Cursor Position	3
>Y	Write to CRT From Input Device	*6
>Z	Dump Screen to CRT of Remote NPC-800 over RS-232	

* Burst Commands

Table 3-4. Command Formats

Input Command	Output Command	String Number	Length (Bytes)	Description
A	G	1	713	State Setup and Configuration
B	H	1	413	State Setup
		2	12	State Display Parameters
		3	6144	State Data
C	I	1	413	State Aux Setup
		2	12	State Aux Display Parameters
		3	6144	State Aux Data
D	J	1	312	Timing Setup
E	K	1	30	Timing Display Parameters
		2	12	Timing Display Parameters
		3	2	Location of First Data Word
		4	1	Collection Status
		5	2048	Timing Data
F	L	1	30	Timing Aux Display Parameters
		2	12	Timing Aux Display Parameters
		3	1	Timing Aux Display Status
		4	2048	Timing Aux Data
	M	1	2	Collection Status
	N	1	20	Test Codes: 6 - State 4 - Timing 6 - Aux State 4 - Aux Timing
	P	1	8	2 - State Trigger Displacement 2 - State Word Count 2 - Timing Trigger Displacement 2 - Timing Word Count
Q	HXHXDDDD	1	DDDD	State Probe A MSB
		2	DDDD	State Probe A LSB
R	HXHXDDDD	1	DDDD	State Probe B MSB
		2	DDDD	State Probe B LSB
S	HXHXDDDD	1	DDDD	State Probe C MSB
		2	DDDD	State Probe C LSB
T	HXHXDDDD	1	DDDD	Timing Probe A
		2	DDDD	Timing Probe B

NOTE

Each logic analyzer byte below (8 bits) is divided into two 4-bit nibbles. An ASCII equivalent byte is then sent for each nibble.

3.19.92 Command Definitions

The following definitions apply to the NPC-800D commands that can be executed from an external controller (either another NPC-800 or a dedicated GPIB CONTROLLER). If the controller is another NPC-800, to avoid local response to commands, the TRANSMIT field of the controller's I/O menu must be ON (see Table 3-4 for command formats).

0 - Initialize All of NPC-800D

This command performs the same function as a power-up reset. All analysis parameters and data are reset, CP/M operating system is reset, and GPIB bus is also reset (Interface Clear is set).

1 - Initialize Analyzer

This command performs the same functions as the 0 command, except for the CP/M operating system and the GPIB bus. Thus, this command can be sent to the internal analyzer from a CP/M program to initialize only the analyzer; the rest of the system is left intact.

2 - Lock Keyboard

This command sets a flag which prevents access to the NPC-800D by unauthorized users at the keyboard.

NOTE

The slave NPC-800D keyboard cannot be locked while in the I/O menu on the master. The user can only execute this function from CP/M or while in the analyzer proper (menu's or data display).

3 - Unlock Keyboard

This command resets the Lock Keyboard flag and restores keyboard access.

4 - Clear CRT

This command causes NPC-800D to blank its CRT. Normally used in conjunction with the Y command, it sends messages to an operator when the NPC-800D is under automatic control.

5 - CONFIGURATION LIST

This command provides a convenient method of calling the NPC-800D's Configuration List.

6 - CONFIGURATION LIST-SELECT 48 CHANNEL STATE

This command calls the Configuration List and sets the cursor at the 48 CHANNEL STATE mode.

7 - DUMP CT/SA VALUE (up to 24 bytes)
8 - NOT USED

9 - COLLECT

This command has the same function as the COLLECT key, but can be executed from any menu.

A - READ STATE SETUP

This command is used to read data into state menu.

B,C - READ STATE DATA

These commands are used to read data into State Aux Memory.

D - READ TIMING SETUP

This command is used to read data into timing menu.

E,F - READ TIMING DATA

These commands are used to read data into Timing Aux Memory.

G - DUMP STATE SETUP

This command is used to dump State Analyzer's setup.

H - DUMP MAIN STATE DATA

This command is used to dump State Analyzer's Main Memory Data.

I - DUMP AUX STATE DATA

This command is used to dump State Analyzer's Aux Memory Data.

J - DUMP TIMING SETUP

This command is used to dump Timing Analyzer's setup.

K - DUMP MAIN TIMING DATA

This command is used to dump Timing Analyzer's Main Memory Data.

L - DUMP AUX TIMING DATA

This command is used to dump Timing Analyzer's Aux Memory Data.

M - DUMP COLLECTION STATUS

This command is used to dump the Analyzer's Collection Status. If not collecting, then dump one byte for the state analyzer and one byte for the timing analyzer.

N - DUMP SIGNATURES

Dump Signatures (20 bytes): A,B,C, Main State Memory; A,B, Main Timing Memory; A,B,C, Aux State Memory; and A,B, Aux Timing Memory Signatures.

Q - NOT USED

This command is not used.

P - DUMP COLLECTION VARIABLES (16 bytes)

This command provides a State Word Count (4 bytes) and a Trigger Displacement (4 bytes); a Timing Word Count (4 bytes) and a Trigger Displacement (4 bytes).

QXXXXYYYY - DUMP STATE A PROBE DATA

This command is used to dump State A Probe data with most significant bytes followed by least significant bytes, where XXXX = start of dump displacement from first word collected and YYYY = word count to dump.

RXXXXYYYY - DUMP STATE B PROBE DATA

See Q command above.

SXXXXYYYY - DUMP STATE C PROBE DATA

See Q command above.

TXXXXYYYY - DUMP TIMING A & B PROBE DATA

This command dumps A Timing Probe data bytes followed by B Timing Probe data bytes (see Q command above).

U - DUMP SCREEN TO RS-232 DEVICE

Vaaaa - SINGLE BYTE MEMORY DUMP

This command is used to dump the byte at HEX address to enabled output ports.

Waaaabb - SINGLE BYTE MEMORY WRITE

This command writes byte bb to address aaaa.

Xpppp - SET SCREEN CURSOR POSITION

This command is used to set cursor position to relative value pppp in decimal (0-1999).

Ydddd..dd$ - WRITE TO SCREEN

This command is used to write data ddd... to the screen cursor location. Terminate data with $. Screen RAM begins at F000(HEX) and ends at F7CF(HEX).

Z - SCREEN DUMP TO REMOTE NPC-800

This command is used to dump a CR and a LF followed by the first 25 lines of the screen to the RS-232C port, if enabled.

3.19.93 Transmission Examples (NPC-800D ONLY)

These examples demonstrate use of NPC-800D's I/O CONFIGURATION menu.

3.19.94 Analyzer Data Transmission

In this example, the transfer of blocks of analyzer data from one NPC-800 to another is demonstrated.

SETUP

Using GPIB bus connectors at rear of unit,connect one NPC-800 to another NPC-800.

For both units, perform the following sequence: turn power switch on or press RESET to produce CONFIGURATION LIST. Then press I key to call the I/O CONFIGURATION MENUS.

3.19.95 Controller (Master)

For unit selected to be the CONTROLLER, the I/O menu is set up in following steps with default values in all fields except GPIB INTERFACE (ENABLED), GPIB MODE (CONTROLLER), MEMORY INPUT (TIMING SETUP), and GPIB OUTPUT (ENABLED). After making sure that GPIB INTERFACE field is enabled, advance cursor to GPIB mode field using NEXT key. If field is set to DEVICE, press SELECT key to set it to CONTROLLER. Access TRANSMISSION INPUT field by pressing I key. Then advance cursor to MEMORY field by pressing NEXT key. Press SELECT key twice to set memory to TIMING SETUP. Then use O key and NEXT key to access GPIB OUTPUT field. Use SELECT key to turn this field ON.

Press CONFIG key to call CONFIGURATION LIST. Select 16-CHANNEL TIMING mode by pressing SEL DOWN key. Call menu with TIMING key. Arbitrarily change two or three of the parameters in the menu.

Press CONFIG key to call CONFIGURATION LIST again. Select I/O CONFIGURATION MENU by pressing I key. At this point, the first NPC-800 (CONTROLLER) is ready to send the timing menu to second NPC-800 (DEVICE) over the GPIB bus (see Figure 3-100).

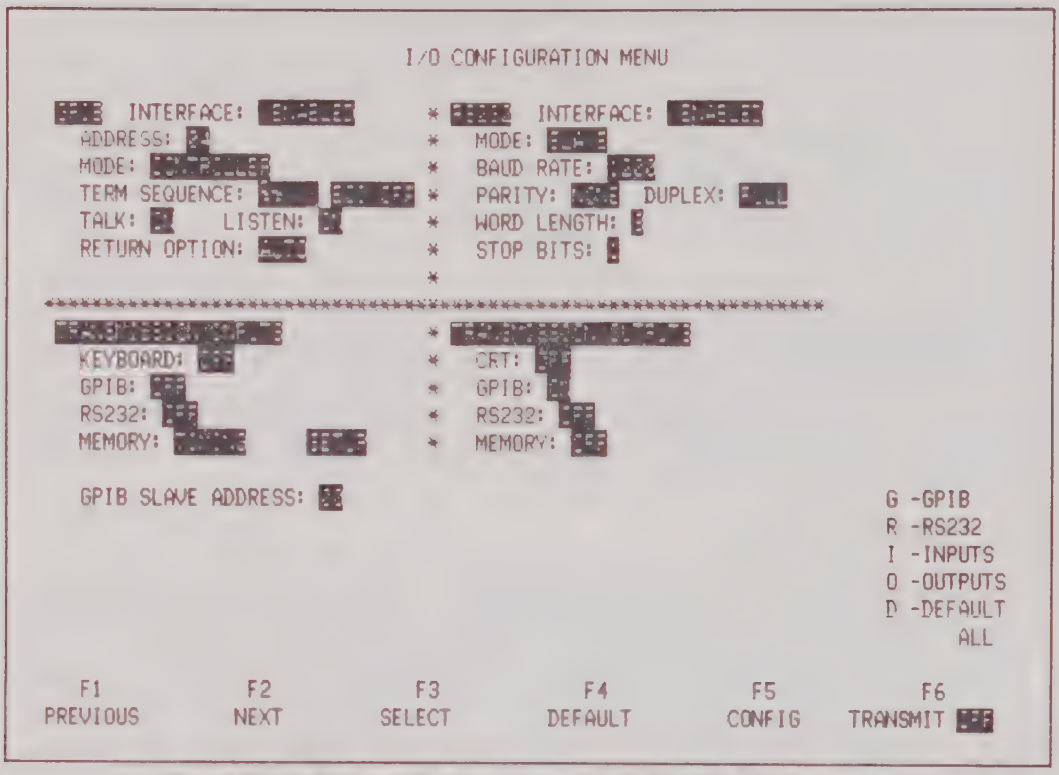

Figure 3-100. I/O Menu For Transmitting Timing Menu To An NPC-800 (acting as DEVICE on GPIB bus)

3.19.96 Device (Slave)

When the NPC-800D acts as a DEVICE, the I/O menu should be set up as shown in Figure 3-101. Notice that DEVICE is selected, DEVICE ADDRESS is set to 00* (using SELECT key), and GPIB INPUT field is ON. At this point, the second NPC-800 is ready to receive the timing menu over the GPIB bus.

* Thirty device addresses are available.

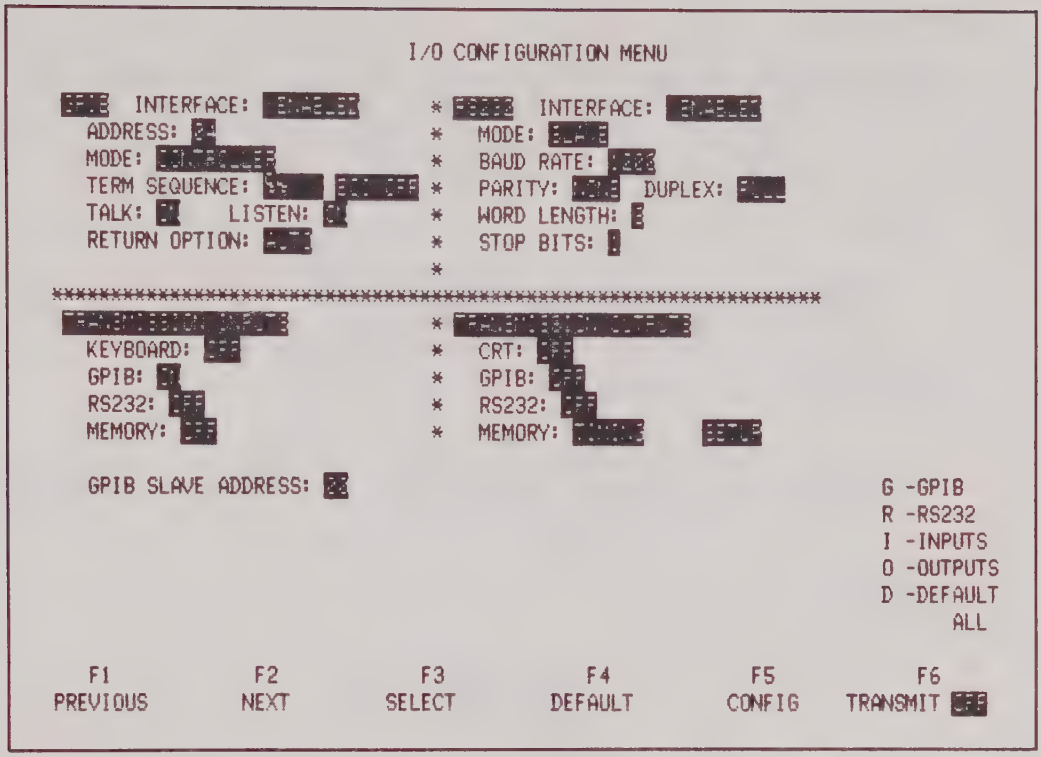

Figure 3-101. I/O Menu For Receiving Timing Menu from another NPC-800D

Return to NPC-800D you set up as a CONTROLLER and press TRANSMIT key to turn field ON. Message DONE will flash on the NPC-800D (acting as a DEVICE when transmission is complete; TIMING SETUP data have been transferred from CONTROLLER.)

To get back to CONFIGURATION LIST, press CONFIG key on second NPC-800 (DEVICE). Select 16-CHANNEL TIMING mode by pressing SEL DOWN key. Call menu with TIMING key. Parameters that were changed in CONTROLLER are also changed in the DEVICE.

3.19.97 MORE I/O EXAMPLES

To further illustrate the instrument's GPIB CONTROLLER/DEVICE capabilities, your NPC-800D's diskette contains a CBASIC program. Called GPIBEX, this program does not require any programming. Through easy-to-use menus, you can control another instrument and transfer data.

3.19.98 Source

By typing: TYPE GPIBEX.BAS., the program listing is available on diskette. This listing will be of interest to users who want to modify these programs for their own application. Type CNTL S to stop screen from scrolling: type any key to start.

3.19.99 GPIBEX

The GPIBEX program allows you to exercise an external GPIB-compatible instrument, or control your NPC-800D's internal analysis functions. In the following example, the internal 48-Channel State Analyzer is exercised by the Controller, as if it were an independent instrument on the GPIB bus:

Procedure

1. To call CP/M operating system, insert diskette and press ESC. Type DIR and RETURN to make certain GPIBEX program is on your diskette (contact factory or your nearest sales office if program is not on your diskette).

CRUN2 OR CRUN23 GPIBEX

2. Type CRUN2 GPIBEX OR CRUN23 GPIBEX (RETURN). When main menu is displayed after a short delay, select LOGIC ANALYZER COMMAND menu (Option 2) as shown in Figure 3-102.

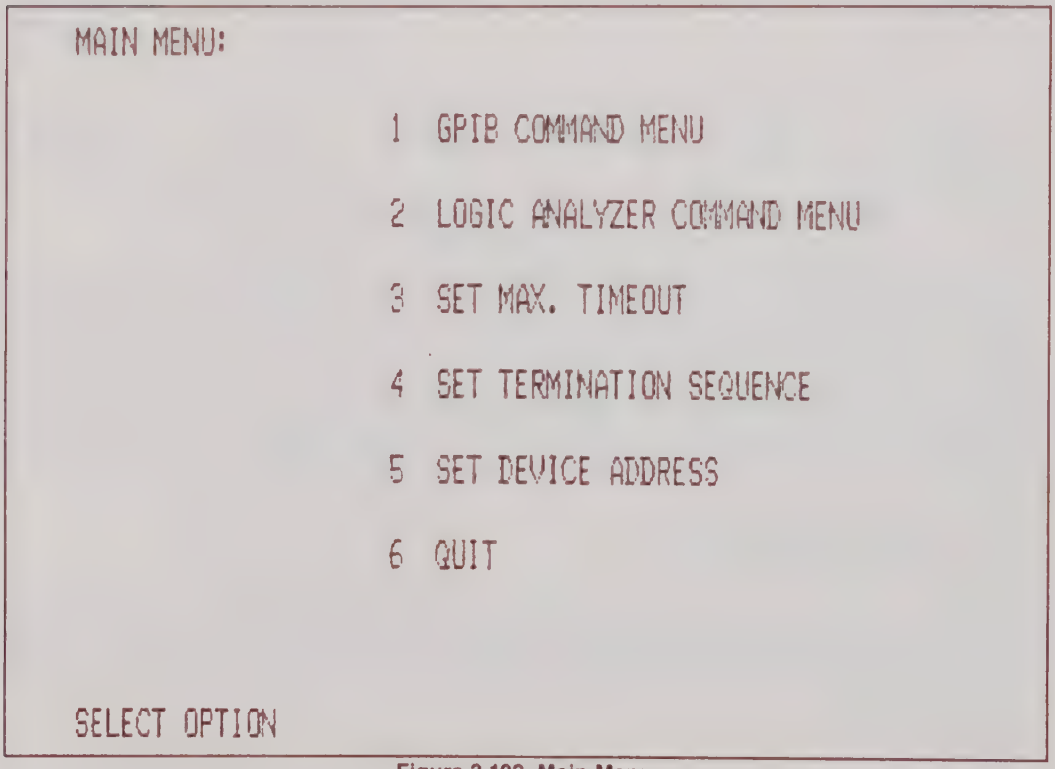

Figure 3-102. Main Menu

Command Menu

3. After pressing RETURN, the LOGIC ANALYZER COMMAND menu is displayed. Select Option: SEND COMMAND TO LOGIC ANALYZER (Option 1) as shown in Figure 3-103.

```
LOGIC ANALYZER COMMAND MENU:

                    1  SEND COMMAND TO LOGIC ANALYZER

                    2  SEND SOFT-KEY COMMAND TO LOGIC ANALYZER

                    3  GO TO LOGIC ANALYZER

                    4  LASAVE

                    5  LARECALL

                    6  GO TO MAIN MENU



SELECT OPTION
```

Figure 3-103. Logic Analyzer Command Menu

NOTE

Selecting Option 1 automatically sets device address for NPC-800D's internal analysis functions.

4. Press RETURN to call header: ENTER COMMAND STRING.

NOTE

In this program, you can only enter one command or menu field setup at a time (see paragraphs 3.19.91 and 3.19.92 for command formats and definitions). Use correct formats; otherwise software may return you to the analyzer operating system (or possibly crash) and the above procedure will have to be repeated from step 1.

5. Type > 1 (RETURN) to initialize analyzer and display CONFIGURATION LIST. Then press RETURN twice to call command menu, as indicated by message on bottom of CRT.

6. Select Option 2 to send a soft-key command and press RETURN. When header: SELECT SOFT-KEY (1-6) appears, type 1 to select F1 (STATE) function which calls the state menu.

7. Observe that the state menu is displayed with cursor in FORMAT field. Call command menu and type 1 and RETURN. When command string header appears, type in 16 As, 16 Bs, and 16 Xs (see Figure 3-104). Next, press RETURN.

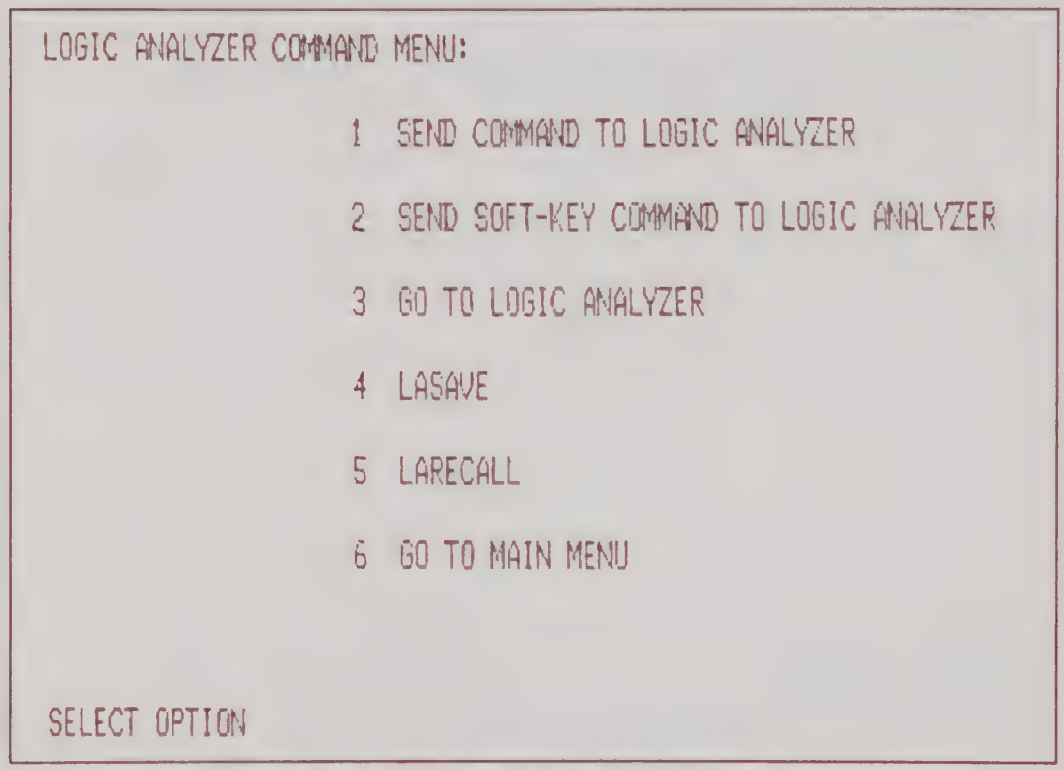
LOGIC ANALYZER COMMAND MENU:
1 SEND COMMAND TO LOGIC ANALYZER
2 SEND SOFT-KEY COMMAND TO LOGIC ANALYZER
3 GO TO LOGIC ANALYZER
4 LASAVE
5 LARECALL
6 GO TO MAIN MENU
SELECT OPTION

Figure 3-104. Setting Up State Format Field

8. The state menu carries out format command as soon as RETURN is pressed. If you want A and B FORMAT fields to be set to hexadecimal and binary, respectively, call command menu, select Option 1, and simply type: H (spacebar) N (RETURN).

9. Next, an event E1 will be defined; the rest of the setup menu remains unchanged. To execute these keystrokes manually, call the command menu, type 3 (RETURN), and press TAB three times and F1 (previous). This positions the cursor for symbolic label definition. Press TAB seven times to reposition the cursor at the top of the menu in the FORMAT field.

10. To execute these keystrokes automatically, call the command menu (RETURN). Type 1 (RETURN) and press TAB four times, then press F1. To enter the "Name" type N-A-M-E (spacebar) 0000 RETURN (see Figure 3-105 for resulting menu).

```
                    48 CHANNEL STATE SET-UP
 FORMAT:  AAAAAAAA AAAAAAAA BBBBBBBB BBBBBBBB XXXXXXXX XXXXXXXX
          +A HEX +B BIN
 CLOCKS:
    EXT R=( Cr ⌐ * Qr X )  S=( Cs ⌐ * Qs X )  T=( Ct ⌐ * Qt X )
        MEMORY 1: R        MEMORY 2: R        MEMORY 3: R        MASTER:   R
 EVENTS:                  Qualifiers: -XYZ EL
  E1 N-A-M-E  =  0000 XXXXXXXXXXXXXXXX -XXX XX

  E2          =  XXXX XXXXXXXXXXXXXXXX -XXX XX                    H - HEX

  E3          =  XXXX XXXXXXXXXXXXXXXX -XXX XX                    O - OCTAL

  E4          =  XXXX XXXXXXXXXXXXXXXX -XXX XX                    Z - DEC

  E5          => XXXX XXXXXXXXXXXXXXXX                            N - BINARY

              =< XXXX XXXXXXXXXXXXXXXX                            Y - ASCII

     TAB - NEXT SENTENCE                          P - PROGRAM MENU
     S1 - DATA DISPLAY                                             U - USER
   F1           F2           F3           F4           F5           F6
 PREVIOUS       NEXT                                   CONFIG       COLLECT
```

Figure 3-105. State Setup Menu

Collect

11. To take a data collection, first make sure the A state probe is connected to test card. Then return to command menu, type 2, and then type 6 for F(6) (COLLECT) (see Figure 3-106).

```
 MAIN          000  003E 0111111111111110
               001  003F 1111111111111111
 LOC:  000     002  0040 0000000000000000
               003  0041 1000000000000001
 SIG: BF17     004  0042 0100000000000010
      4817     005  0043 1100000000000011
      D8D3     006  0044 0010000000000100
               007  0045 1010000000000101
               008  0046 0110000000000110
               009  0047 1110000000000111
               010  0048 0001000000001000
               011  0049 1001000000001001
               012  004A 0101000000001010
               013  004B 1101000000001011
               014  004C 0011000000001100
               015  004D 1011000000001101
               016  004E 0111000000001110
```

Figure 3-106. Corresponding State Display

Direct

12. Once data are displayed, you can rapidly access a desired field of the state menu by sending a direct entry command, such as Q or P.

NOTE

S1 or S2 (DATA DISPLAY) function is not available in the GPIBEX program.

Experiment with other portions of the GPIBEX program using state or other NPC-800D internal analyzer functions. This program is useful for examining the operation of external GPIB instruments.

3.20 RS-232C REMOTE LOGIC ANALYSIS

The NPC-800D provides logic analysis capabilities for virtually every application. For example, in field service, an engineer is sent into the field with a logic analyzer to perform system-level troubleshooting. If assistance is needed from his home office, he simply connects the NPC-800D to a modem to permit remote control.

Using the RS-232C port, which is similar to IEEE-488 control, the NPC-800D allows full control of the logic analyzer. In fact, most commands are the same for either RS-232C or IEEE-488 control, they simply enter the NPC-800D on different ports.

This section provides command structure definitions, illustrating an example of one NPC-800 controlling another NPC-800, linked by an RS-232C cable.

3.20.1 Computer Control Via RS-232C

A second example illustrates how the NPC-800D can be controlled by a personal computer (actually another NPC-800), that uses a program written in CBASIC, and sending commands via the RS-232C port.

3.20.2 Interface Connections

The connection uses standard EIA levels of ±12 volt amplitude (positive true logic) and are described in the following list (unlisted pin numbers are not used by the NPC-800D).

3.20.3 RS-232C Pin Definitions

PIN 1 — Chassis and Logic Ground.

PIN 2 — Serial In; Disk/RAM Controller (DRC) board can be "strapped" to configure this pin as Serial Out.

PIN 3 — Serial Out; Disk/RAM Controller (DRC) board can be "strapped" to configure this pin as Serial In.

PIN 4 — Return to Send (RTS). (Programmable). Upon power-on reset, RTS is normally "ON."

PIN 5 — Clear to Send (CTS). If data are transmitted to NPC-800D, this pin must be pulled up so that if disconnected, it is normally high (ON).

PIN 6 — Data Set Ready (DSR). Status bit DSR is readable, if desired, and is pulled up so it is normally high (ON).

PIN 7 — Logic Ground.

PIN 8 — Data Carrier Detect (DCD). Status bit DCD is readable, if desired, and is pulled up so it is normally high (ON).

PIN 20 — Data Terminal Ready (DTR). Programmable DTR is driven by software and is normally (ON).

All other pins are disconnected. "Pulled high" means the pin is tied to +15 volts through a resistor.

3.20.4 Interface Configuration

The RS-232C interface is implemented using a Rockwell (Synertek) 6551A chip. This chip is user-programmable to suit desired interface conditions.

The NPC-800D interfaces to other RS-232C compatible equipment. Refer to the 6551A chip manufacturer's data manual (Rockwell/Synertek).

3.20.5 Control Register Command Register

The control register selects the mode of the chip with regard to word length, number of stop bits and clock controls. The command register is used to control specific transmit/receive functions. These are programmed automatically when power is initially applied, and are set up in accordance to the dip switch located on the Processor Board (in card cage) inside the NPC-800D as shown in Figure 3-107 (see Figure 3-108 for dip switch settings).

NOTE

Default condition for CHARACTER LENGTH is 8 bits with 1 STOP bit. Parity is disabled.

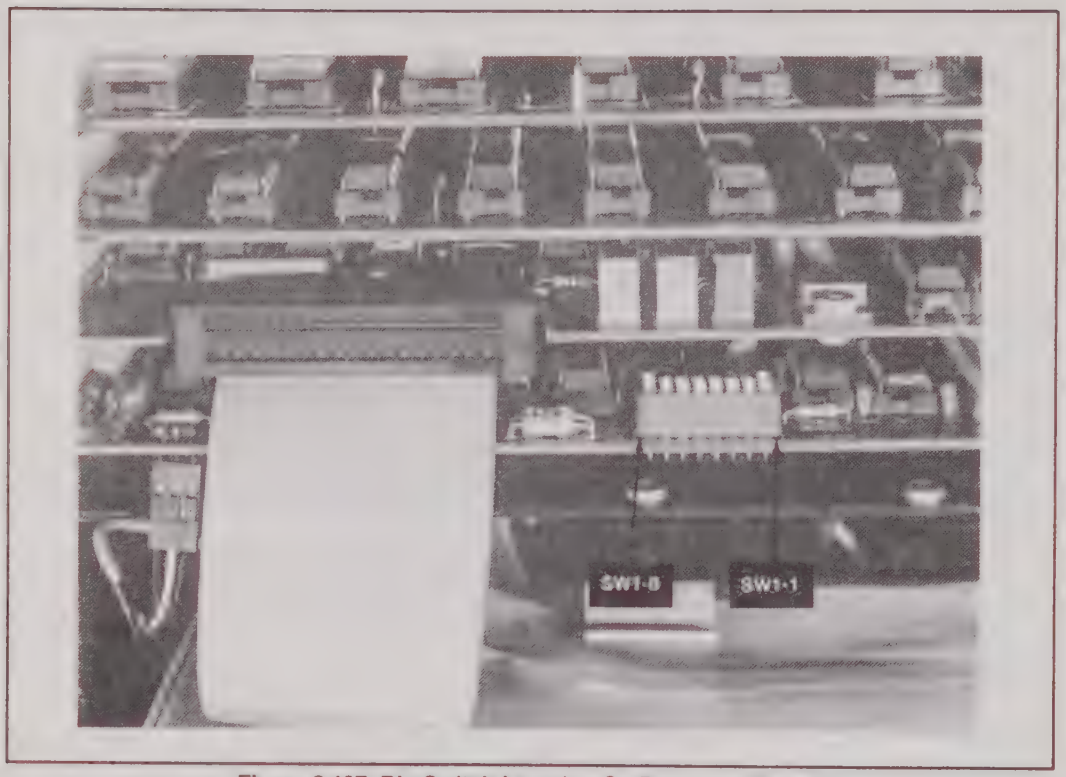

Figure 3-107. Dip Switch Location On Processor Board

3.20.6 RS-232C Setup

RS-232C interface is set up from keyboard using I/O configuration menu (see paragraph 3.20.10).

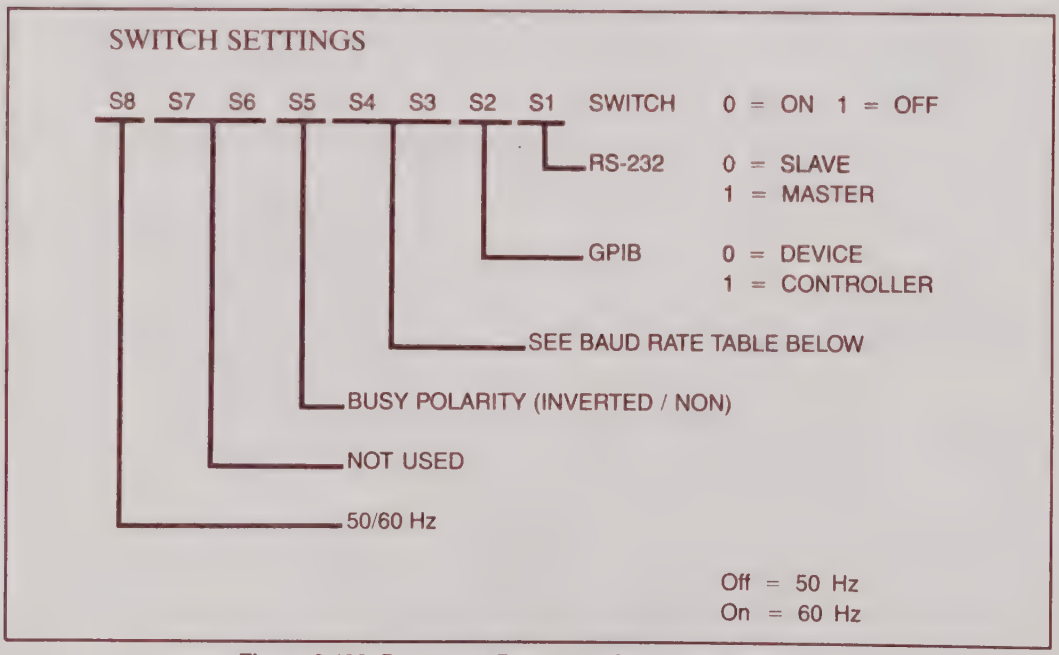
SWITCH SETTINGS
S8 S7 S6 S5 S4 S3 S2 S1 SWITCH 0 = ON 1 = OFF
RS-232 0 = SLAVE 1 = MASTER
GPIB 0 = DEVICE 1 = CONTROLLER
SEE BAUD RATE TABLE BELOW
BUSY POLARITY (INVERTED / NON)
NOT USED
50/60 Hz
Off = 50 Hz
On = 60 Hz

Figure 3-108. Processor Board DIP Switch Settings

3.20.7 Default Baud Rate

The DIP switch settings for power-on default baud rate are as follows:

S4	S3	BAUD RATE
0	0	300
0	1	1200
1	0	4800
1	1	9600

3.20.8 Remote Control Example

In this example, the NPC-800D communicates with another device over the RS-232 interface. The device should be capable of displaying and transmitting ASCII data (such as a data terminal).

3.20.9 Setup

Connect NPC-800D to terminal using RS-232 interface at rear of analyzer. Ensure terminal is configured as follows:

BAUD RATE	1200
PARITY	NONE
DUPLEX	HALF
WORD LENGTH	8
STOP BITS	1

NOTE

If settings on terminal are not easily changed, NPC-800D's parameters can be changed using RS-232 section of I/O configuration menu.

3.20.10 I/O Configuration Menu

To Call Menu:

1. Press CONFIG or RESET key.
2. Press 1 key.

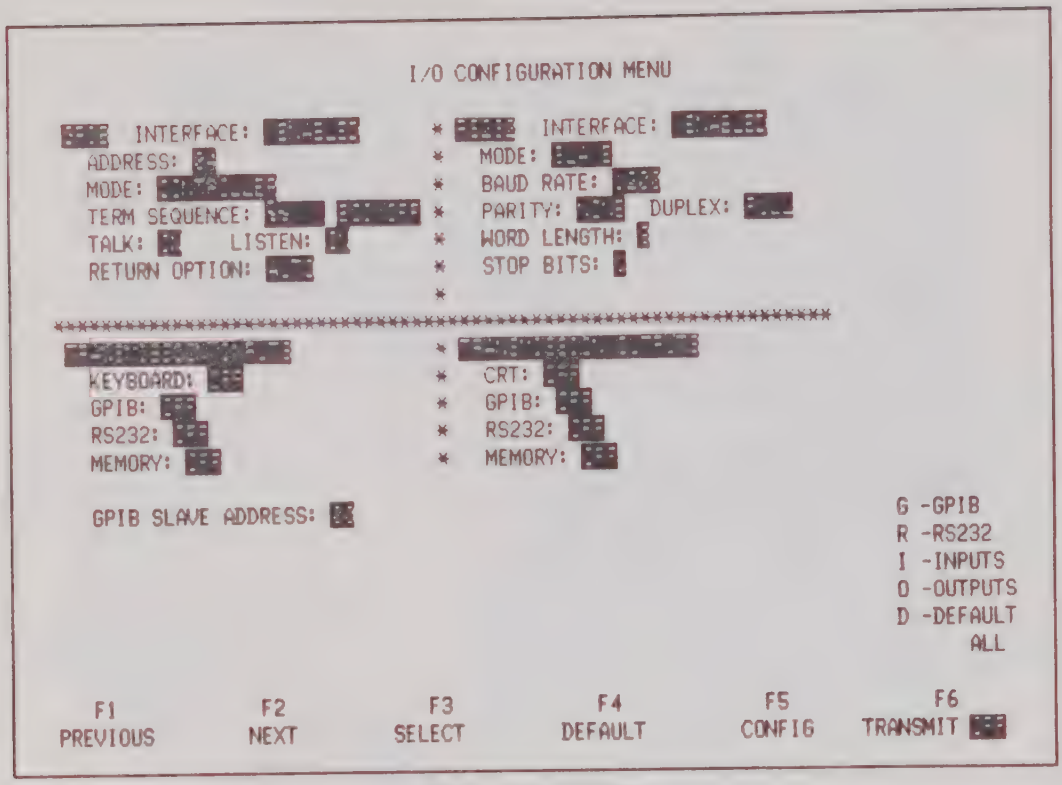

Figure 3-109. I/O Menu

3.20.11 RS-232 Section Interface

The INTERFACE field defaults to ENABLED to allow the NPC-800D to communicate with other devices via an RS-232 bus. After accessing this field, pressing SELECT key puts interface into a DISABLED state which effectively disconnects the device from the bus. If ENABLED mode is selected, the NPC-800D can either be a MASTER or SLAVE on the bus.

3.20.12 Mode

MODE field allows you to reconfigure the NPC-800D to become either MASTER or SLAVE on an RS-232 bus. Default condition is set by switch 1 on DIP switch located on Processor Board (see Figure 3-98). The unit is a MASTER if the switch (S1) is in the OFF position (switch is read during power up and when RESET key is pressed; see Table 3-5). A third mode of operation, MASTER/ECHO, is also available. This mode is identical to MASTER, except that all commands executed by the NPC-800D are echoed from the RS-232 port (except when in I/O configuration menu). This feature is useful when it is desired to set up the MASTER and SLAVE in the same configuration, or to simply see the SLAVE's menus when entering commands manually. The SELECT Key Changes the mode from SLAVE to MASTER to MASTER/ECHO.

The BAUD RATE field defines the RS-232 transmission rate; field defaults to 1200. Use following keys to select desired baud rate:

Table 3-5. Baud Rate Select

KEY	BAUD RATE
1	110
2	150
3	300
4	600
5	1200
6	2400
7	4800
8	9600

NOTE

Above information is displayed on CRT when BAUD RATE field is activated.

3.20.13 Parity

PARITY field defaults to NONE. Pressing SELECT key allows you to set PARITY to NONE, ODD, EVEN, MARK, or SPACE.

3.20.14 Duplex

DUPLEX field defaults to FULL which enables Echo mode for RS-232 interface. Pressing SELECT key allows you to set DUPLEX field to HALF or FULL.

3.20.15 Word Length

WORD LENGTH field defaults to 8. Pressing SELECT key allows you to set WORD LENGTH to 8,7,6, or 5 bits.

3.20.16 Stop Bits

STOP BITS field defaults to 1. Pressing SELECT key allows you to set number of STOP BITS to 1 or 2. Notice that some combinations of parity and word length force the number of stop bits to a specific state. For example, if word length is selected to be 8 and parity is selected, 1 stop bit is sent even though 2 stop bits may have been selected; if word length is 5 and no parity is selected, 1.5 stop bits are sent if 2 stop bits are selected.

3.20.17 Transmission Inputs

This section defines data source(s) that are sent to the interface or memory defined in the TRANSMISSION OUTPUTS section, described below.

3.20.18 Keyboard

KEYBOARD field normally defaults to OFF. The keyboard can only be used to configure and control the analyzer in the OFF state. With OFF cursor flashing, pressing SELECT key turns KEYBOARD field ON to transmit data to interface(s) selected in TRANSMISSION OUTPUTS section.

3.20.19 GPIB

GPIB field normally defaults to OFF. If INTERFACE field in GPIB section of menu is DISABLED, GPIB field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key turns this field ON and enables NPC-800D to receive data from another device over the GPIB bus and to send data to destination(s) selected in TRANSMISSION OUTPUTS section.

3.20.20 RS-232

RS-232 field normally defaults to OFF. If INTERFACE field in RS-232 section of menu is DISABLED, RS-232 field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key turns this field ON and enables NPC-800D to receive data from another device over RS-232 interface and to send data to destination(s) selected in TRANSMISSION OUTPUTS section.

3.20.21 Memory

MEMORY field normally defaults to OFF. If MODE field in GPIB section is set to DEVICE and mode field in RS-232 section is set to SLAVE, field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key provides several combinations of memory data to be transmitted over GPIB or RS-232 interfaces. With field flashing, pressing SELECT key allows you to select TIMING or STATE memory to be transmitted. Pressing NEXT key moves flashing cursor to SETUP field. With SETUP field flashing, pressing SELECT key allows you to select memory type to be transmitted. Choices are SETUP, DATA, or AUX. Pressing DEFAULT key when either field is flashing sets both fields to OFF.

3.20.22 Transmission Outputs Section

3.20.23 CRT

CRT field normally defaults to OFF. CRT displays configuration menus and data collection displays in OFF state. With OFF cursor flashing, pressing SELECT key turns CRT ON to display data received on interface(s) selected in TRANSMISSION INPUTS section.

3.20.24 GPIB

GPIB field normally defaults to OFF. If INTERFACE field in GPIB section of menu is DISABLED, GPIB field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key turns this field ON and enables NPC-800D to transmit data to another device over GPIB bus. Data sent are from source(s) selected in TRANSMISSION INPUTS section.

3.20.25 RS-232

RS-232 field normally defaults to OFF. If INTERFACE field in RS-232 section of menu is DISABLED, RS-232 field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key turns this field ON and enables NPC-800D to transmit data to another device over RS-232 interface. Data sent are from source(s) selected in TRANSMISSION INPUTS section.

3.20.26 Memory

MEMORY field normally defaults to OFF. If MODE field in GPIB section is set to DEVICE and MODE field in RS-232 section is set to SLAVE, field is forced to OFF and cannot be changed. With OFF cursor flashing, pressing SELECT key provides several memory combinations to receive data from another NPC-800D over interface selected in TRANSMISSION INPUTS section. With field flashing, pressing SELECT key allows you to select TIMING OR STATE memory to receive data. Pressing NEXT key moves flashing cursor to SETUP field. With SETUP field flashing, pressing SELECT key allows you to select memory type to receive data. Choices are SETUP, DATA, or AUX. Pressing DEFAULT key when either field is flashing sets both fields to OFF.

3.20.27 GPIB SLAVE ADDRESS*

GPIB SLAVE ADDRESS field is displayed only if MODE field in GPIB section is set to CONTROLLER. Pressing SELECT key increments address. Valid addresses are 00 through 30 (HEX). The field defines GPIB address of another NPC-800 (or other device*) to which data or memory block are sent as defined in TRANSMISSION INPUTS or OUTPUTS section.

3.20.28 LABELS

These fields are labels that define functions of direct entry keys. Pressing G, R, I, or O moves flashing cursor to associated section of menu. Pressing D sets every field to its default state.

* Not used with the RS-232C

If MEMORY input or MEMORY output is selected, the TRANSMIT key initiates data transmission. The field shows TRANSMIT ON during transmission and changes back to TRANSMIT OFF upon transmission completion.

NOTE

Only one MEMORY (input or output) is allowed to be selected. The other MEMORY is forced to OFF.

3.20.29 MENU Setup

To call the CONFIGURATION LIST, press RESET key and hold it down for at least two seconds. Select I/O CONFIGURATION MENU by pressing I key. Make sure RS-232 INTERFACE field is ENABLED. Advance blinking cursor to KEYBOARD field by pressing I (INPUTS) key. Press SELECT key to enable keyboard inputs (to be transmitted when pressed). To enable NPC-800D to receive data over RS-232 interface, use NEXT and SELECT keys to turn RS-232 INPUT field ON. Advance cursor to CRT field by pressing O (OUTPUTS) key. Press SELECT key to turn this field ON, enabling CRT to display input data. Move blinking cursor to RS-232 OUTPUT field by pressing NEXT key. Press SELECT key to turn this field ON which, in turn, enables data transmission over the RS-232 interface (see Figure 3-110).

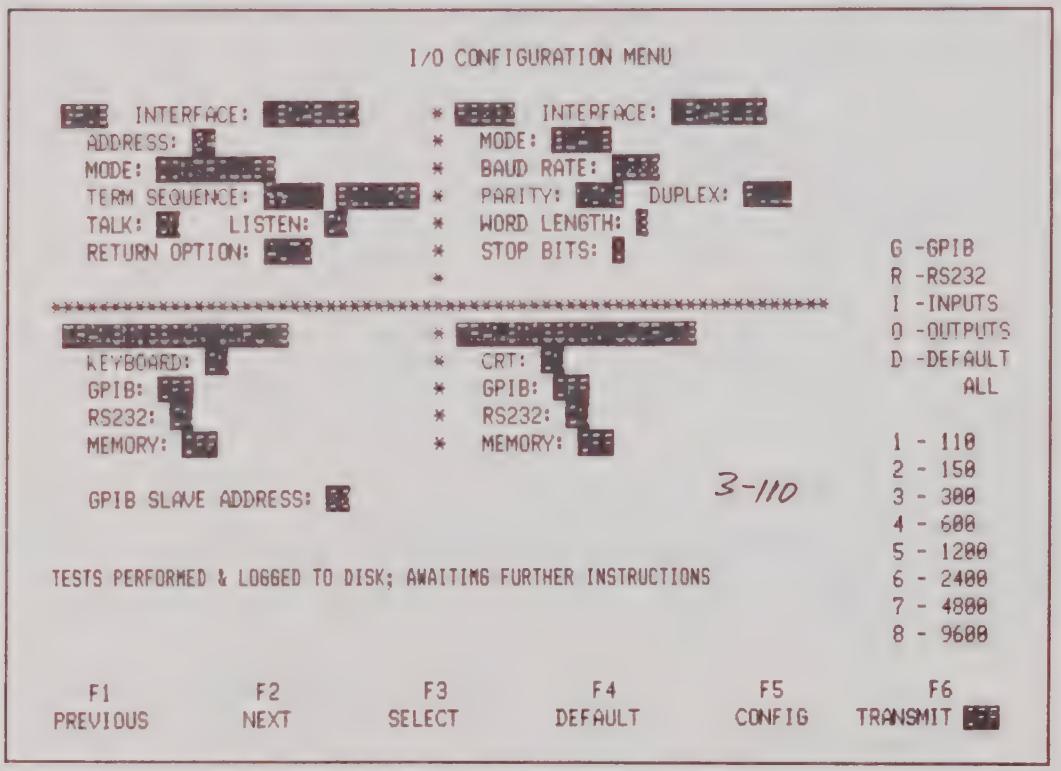

Figure 3-110. I/O CONFIGURATION MENU
(Used To Transmit Keystrokes to Another Device Such as a Terminal)

3.20.30 TRANSMIT

Press TRANSMIT (F6) key. To indicate that transmission and reception are enabled, TRANSMIT key label changes to ON. Type a few characters on NPC-800D keyboard. Notice that characters appear on NPC-800D's CRT, (see Figure 3-100), and on printer or CRT. Now type a few characters on terminal keyboard; characters appear on NPC-800D's CRT.

Press TRANSMIT key again. Key label now changes to OFF. Check RS-232 MODE field. It should be set to SLAVE (if not, use R, NEXT, AND SELECT keys to call SLAVE mode). Type CTRL T on terminal's keyboard; blinking cursor moves to next field (CTRL S moves cursor to previous field). Type an R on terminal keyboard (cursor moves to RS-232 INTERFACE field). In this mode, data or keystrokes from terminal are executed by NPC-800D as if keys on its own keyboard were being pressed.

3.20.31 RS-232

When using NPC-800D's RS-232 interface, there are no command sequence restrictions. Commands are executed as they are input. RS-232 operation requires that electrical interface be set up in accordance with proper pin definitions and that baud rate be matched between NPC-800D and terminal.

For non-ASCII control formats, use conversion table in the Appendix of this manual.

The following commands enable NPC-800D special keys to be controlled remotely from an RS-232 terminal:

NPC-800D Key	Remote Command
S1	CNTL Q
S2	CNTL R
F1	CNTL S
F2	CNTL T
F3	CNTL U
F4	CNTL V
F5	CNTL W
F6	CNTL X
SCREEN DUMP	U or Z

3.20.32 Commands That Return Data

Table 3-6 contains a summary of all commands that return data from the analyzer. Some commands are returned as several strings of ASCII characters on the IEEE-488 bus, each terminated with a Carriage Return/Line Feed. Data are ASCII-encoded HEX: therefore the number of characters transmitted will be twice the number of data bytes shown in Table 3-7.

Table 3-6. Command Formats and Field Definitions

Format Number	Format	Field Definitions
1	A	Keyboard Commands
2	A	Bus Commands
3	A HXHX	Address
4	A HXHX DDDD	Number of Hex Pairs Address
5	A HXHX HX	Data Address
6	A AAA...	 ASCII Data

HX = Hexadecimal Pair (i.e., OF)
D = Decimal Digit
A = ASCII Character

Table 3-7. NPC-800D Command List (Other than Keyboard Commands)

Command	Description	Format Number
0	Initialize All	2
1	Initialize Logic Analyzer (excluding I/O menu)	2
2	Lock Keyboard	2
3	Unlock Keyboard	2
4	Clear CRT	2
5	CONFIGURATION LIST	2
6	CONFIGURATION LIST-SELECT 48 CHANNEL STATE	2
7	Not Used	2
8	Not Used	2
9	Collect	2
A	Read State Setup	*6
B	Read State Data to Aux Memory	*6
C	Same as above.	*6
D	Read Timing Setup	*6
E	Read Timing Data to Aux Memory	*6
F	Same as above.	*6
G	Dump State Setup	2
H	Dump State Data	2
I	Dump State Aux	2
J	Dump Timing Setup	2
K	Dump Timing Data	2
L	Dump Timing Aux	2
M	Dump Collection Status	2
N	Dump Signatures	2
P	Dump Collection Variables	2
Q	Dump State Probe A Data	4
R	Dump State Probe B Data	4
S	Dump State Probe C Data	4
T	Dump Timing Data	4
U	Dump Screen to RS-232 Device	
V	Dump Byte from Memory to Output Device	3
W	Write Byte to Memory from Input Device	5
X	Set CRT Cursor Position	3
Y	Write to CRT From Input Device	*6
Z	Dump Screen to CRT of Remote NPC-800D over RS-232	

* Burst Commands

Table 3-8. Command Formats

Input Command	Output Command	String Number	Length (Bytes)	Description
A	G	1	713	State Setup and Configuration
B	H	1	413	State Setup
			12	State Display Parameters
		3	6144	State Data
C	I	1	413	State Aux Setup
		2	12	State Aux Display Parameters
		3	6144	State Aux Data
D	J	1	312	Timing Setup
E	K	1	30	Timing Display Parameters
		2	12	Timing Display Parameters
		3	2	Location of First Data Word
		4	1	Collection Status
		5	2048	Timing Data
F	L	1	30	Timing Aux Display Parameters
		2	12	Timing Aux Display Parameters
		3	1	Timing Aux Display Status
		4	2048	Timing Aux Data
	M	1	2	Collection Status
	N	1	20	Test Codes: 6 - State 4 - Timing 6 - Aux State 4 - Aux Timing
	P	1	8	2 - State Trigger Displacement 2 - State Word Count 2 - Timing Trigger Displacement 2 - Timing Word Count
Q	HXHXDDDD	1	DDDD	State Probe A MSB
		2	DDDD	State Probe A LSB
R	HXHXDDDD	1	DDDD	State Probe B MSB
		2	DDDD	State Probe B LSB
S	HXHXDDDD	1	DDDD	State Probe C MSB
		2	DDDD	State Probe C LSB
T	HXHXDDDD	1	DDDD	Timing Probe A
		2	DDDD	Timing Probe B

NOTE

Each logic analyzer byte below (8 bits) is divided into two, 4-bit nibbles. An ASCII equivalent byte is then sent for each nibble.

3.20.33 Command Definitions

The following definitions apply to NPC-800D commands you can execute from an external controller. The controller can be another NPC-800D or a dedicated GPIB CONTROLLER. If the controller is another NPC-800D, the TRANSMIT field of the controller's I/O menu must be ON to avoid local response to commands (see Table 3-8 for command formats).

0 - Initialize All of NPC-800D

This command performs the same function as a power-up reset. All analysis parameters and data are reset, CP/M operating system is reset, and GPIB bus is also reset (Interface Clear is set).

1 - Initialize Analyzer

This command performs the same functions as the 0 command, except for the CP/M operating system and the GPIB bus. Thus, this command can be sent to the internal analyzer from a CP/M program to initialize only the analyzer and leave the rest of the system intact.

2 - Lock Keyboard

This command sets a flag which prevents access, through the keyboard, to the NPC-800D (by unauthorized users).

NOTE

The slave NPC-800 keyboard cannot be locked while in I/O menu on master. The user can only execute this function from CP/M or while in the analyzer (menu's or data display).

3 - Unlock Keyboard

This command resets Lock Keyboard flag and restores keyboard access.

4 - Clear CRT

This command causes NPC-800D to blank its CRT. Normally used with the Y command, it sends messages to an operator when the NPC-800D is under automatic control.

5 - CONFIGURATION LIST

This command provides a convenient method of calling the NPC-800D's Configuration List.

6 - CONFIGURATION LIST-SELECT 48 CHANNEL STATE

This command calls the Configuration List and sets cursor at 48 CHANNEL STATE mode.

7 - DUMPS CT/SA VALUE

8 - NOT USED

9 - COLLECT

This command has the same function as COLLECT key, but can be executed from any menu.

A - READ STATE SETUP

This command is used to read data into state menu.

B,C - READ STATE DATA

These commands are used to read data into State Aux Memory.

D - READ TIMING SETUP

This command is used to read data into timing menu.

E,F - READ TIMING DATA

These commands are used to read data into Timing Aux Memory.

G - DUMP STATE SETUP

This command is used to dump State Analyzer's setup.

H - DUMP MAIN STATE DATA

This command is used to dump State Analyzer's Main Memory Data.

I - DUMP AUX STATE DATA

This command is used to dump State Analyzer's Aux Memory Data.

J - DUMP TIMING SETUP

This command is used to dump Timing Analyzer's setup.

K - DUMP MAIN TIMING DATA

This command is used to dump Timing Analyzer's Main Memory Data.

L - DUMP AUX TIMING DATA

This command is used to dump Timing Analyzer's Aux Memory Data.

M - DUMP COLLECTION STATUS

This command is used to dump the Analyzer's Collection Status. If not collecting, then dump one byte for state analyzer and one byte for timing analyzer.

N - DUMP SIGNATURES

Dump Signatures (20 bytes): A,B,C, Main State Memory; A,B, Main Timing Memory; A,B,C, Aux State Memory; and A,B, Aux Timing Memory Signatures.

Q - NOT USED

This command is not used.

P - DUMP COLLECTION VARIABLES (16 bytes)

This command provides a State Word Count (4 bytes) and a Trigger Displacement (4 bytes); a Timing Word Count (4 bytes) and a Trigger Displacement (4 bytes).

QXXXXYYYY - DUMP STATE A PROBE DATA

This command is used to dump State A Probe data with most significant bytes followed by least significant bytes, where XXXX = start of dump displacement from first word collected and YYYY = word count to dump.

RXXXXYYYY - DUMP STATE B PROBE DATA

See Q command above.

SXXXXYYYY - DUMP STATE C PROBE DATA

See Q command above.

TXXXXYYYY - DUMP TIMING A & B PROBE DATA

This command dumps A Timing Probe data bytes followed by B Timing Probe data bytes (see Q command above).

U - DUMP SCREEN TO RS-232 DEVICE

Vaaaa - SINGLE BYTE MEMORY DUMP

This command is used to dump byte at HEX address to enabled output ports.

Waaaabb - SINGLE BYTE MEMORY WRITE

This command writes byte bb to address aaaa.

3.20.34 More I/O Examples

To further illustrate the GPIB CONTROLLER/DEVICE and RS-232 MASTER/SLAVE capabilities, your NPC-800D's diskette contains two CBASIC programs. These programs are called GPIBEX and RS232EX; they do not require any programming to use. Through easy-to-use menus, you can control another instrument and transfer data.

3.20.35 Source

Source listings for both programs are available on the diskette. Just type: TYPE GPIBEX.BAS or TYPE RS232EX.BAS. These listings will be of interest to those who want to modify such programs for their own application (type CNTL S to stop screen from scrolling; type any key to start).

3.20.36 RS232EX

The RS232EX program demonstrates the use of the NPC-800D's MASTER/SLAVE capability. For this program two NPC-800s, tied together via the RS-232C interface, are required.

3.20.37 Procedure Setup

1. Define one NPC-800D as a MASTER and the other as SLAVE so that upon power-on reset, the master defaults to "MASTER" and the slave to "SLAVE" (see paragraph 3.20.12). Connect an RS-232 male-to-male cable between units.

PINS 2 & 3

BE SURE PINS 2 AND 3 ARE SWAPPED ON ONE END (use a break-out box or equivalent).

CRUN2 RS232EX OR CRUN23 RS232EX

2. Press RESET and type 1 for both units. On unit defined as a SLAVE, make sure that GPIB INTERFACE field is DISABLED; RS-232 MODE field is set to SLAVE. On unit defined as a MASTER, set up I/O CONFIGURATION MENU the same as for SLAVE, except be sure RS-232 MODE field is set to MASTER. On both units call the CONFIGURATION LIST. Then, for the MASTER, press ESC and type CRUN2 RS232EX.

3. On all test cards, connect each NPC-800D's A state probe to the A input connector. Be sure both probes are set to TRUE and TTL.

COMPARE UUT

4. When MAIN MENU appears, select option 1, COMPARE UUT DATA WITH "GOLDEN UNIT," and when LOGIC ANALYZER SETUP MENU appears, select: SETUP DATA WITH SIMPLE TRIGGER. At this point, follow directions to execute a pre-stored test in both units simultaneously.* The program concludes by comparing test codes to see if data collections match.

Other Logic Analyzer Setups

5. After program displays test codes, return to MAIN MENU; again select Option 1. Then experiment with other logic analyzer setups (go back to Step 2 to set up I/O CONFIGURATION MENU as before). Option 2 is similar to Option 1 except a more complex, multi-level trigger test is executed; Option 3 allows you to recall your own, previously saved file (using LASAVE). Option 4 allows you to use a manually set-up test.

* Messages TRANSMITTING and RECEIVING appear at appropriate points in each test step. It takes several seconds to several minutes, depending on the amount of data and data rate used, to complete data transfer between units.

Additional RS-232 Tests

6. Other RS232EX options are: VIEW/MODIFY LOGIC ANALYZER SETUP, which allows you to manually edit or revise MASTER's test setup;** SAVE CURRENT SETUP & DATA, allows you to store revised test on diskette for execution by Option 1 (COMPARE UUT DATA WITH 'GOLDEN UUT'). The last option, Option 4, allows you to exit.

** After editing logic analyzer menus, call CONFIGURATION LIST and type R to return to automatic control.

Section 4
Service

4.1 INTRODUCTION

This section provides basic servicing information that will help confirm if an equipment problem really does exist and if it is possible to isolate it to a specific assembly. And, to prevent equipment failures, it also provides recommended routine maintenance information.

In-depth troubleshooting information is not provided. Being beyond the scope of this manual, that level of repair should be performed only by trained personnel. The Maintenance Manual contains schematic diagrams, theory of operation, required equipment lists, and parts lists.

NOTE

If Your NPC-800D Was Damaged During Shipment, Refer to Section 4.4.

4.1.1 Air Filter Maintenance

To assure proper internal cooling of your NPC-800D, periodically clean the air filter. Frequency depends on the operating environment; however filters should be cleaned at least once every six months.

Filter is located on analyzer's upper-rear corner. It is held in place by three brackets attached with phillips head screws. To remove filter, loosen and remove knurled thumbnut which holds bottom bracket in place. Remove bracket from threaded stud. To remove, slide filter down and out.

Clean filter with soap and water, a mild solvent, or with air. Dry filter and depress inner surface gently so that filter material bulges outward, away from seam in filter's frame. Replace filter in two upper brackets, making certain that seam in frame is facing outward. Replace lower bracket and tighten thumbnut "finger-tight."

4.2 PERFORMANCE VERIFICATION TESTS

The tests described below simply confirm that the basic system is functioning, they will not identify the location of a problem. If these tests are not executed successfully, contact the nearest Nicolet Paratronics service facility. If these tests do execute properly, go to appropriate subsection of Section 3 and perform examples described there, using the demonstration circuit board supplied with your NPC-800D. Those procedures will confirm whether the feature with which you are having difficulty is performing properly.

If you cannot execute the procedures in Section 3 properly, contact the nearest Nicolet Paratronics service facility.

4.2.1 Initialization

When the NPC-800D is first switched on, a processor test series can be performed that checks the RAM, ROM, and other subsystems. As indicated at the bottom of the CONFIGURATION LIST, pressing BREAK key activates PROCESSOR SELF-TEST.

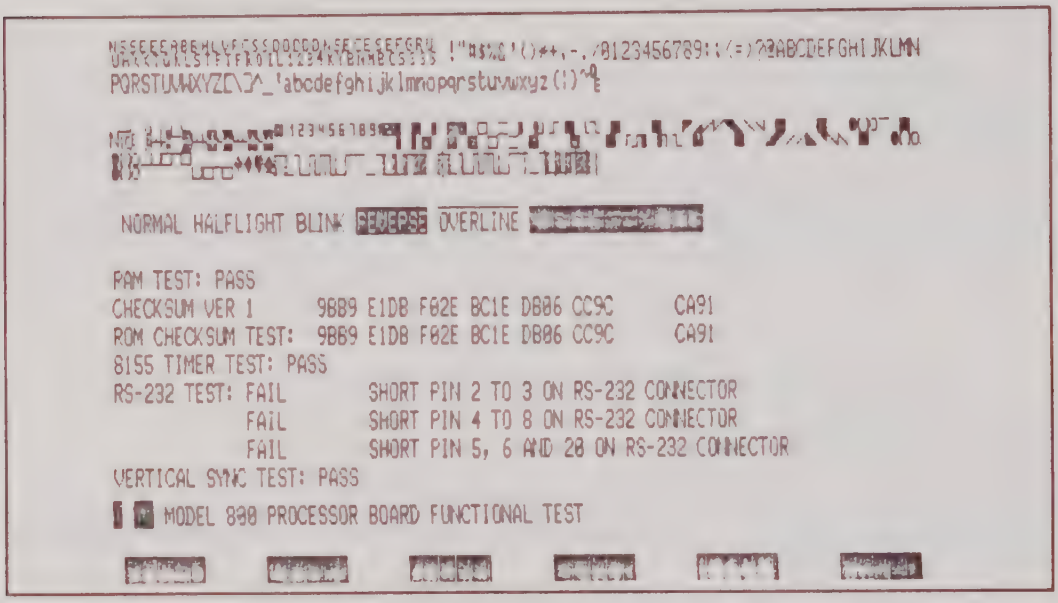
PQRSTUVWXYZ[\]^_`abcdefghijklmnopqrstuvwxyz{|}~
NORMAL HALFLIGHT BLINK REVERSE OVERLINE
RAM TEST: PASS
CHECKSUM VER 1 9B89 E1DB F82E BC1E DB86 CC9C CA91
ROM CHECKSUM TEST: 9B89 E1DB F82E BC1E DB86 CC9C CA91
8155 TIMER TEST: PASS
RS-232 TEST: FAIL SHORT PIN 2 TO 3 ON RS-232 CONNECTOR
FAIL SHORT PIN 4 TO 8 ON RS-232 CONNECTOR
FAIL SHORT PIN 5, 6 AND 20 ON RS-232 CONNECTOR
VERTICAL SYNC TEST: PASS
MODEL 800 PROCESSOR BOARD FUNCTIONAL TEST

Figure 4-1. Processor Self-Test

4.2.2 Basic State Analyzer Collection

1. Insert a Model 51A State Probe into A (STATE) input on left side of NPC-800D. Make sure plastic key on probe connector is facing up.

2. Plug probe head into A side of Logic Analyzer Test Card. Be sure probe switches are set to TTL and TRUE.

3. Turn power on using power switch in right rear side of NPC-800D.* If unit is cold, wait up to 30 seconds for CONFIGURATION LIST to appear. The half-intensity cursor should be located at top of list.

4. Press F6 key, labeled COLLECT on CRT, to take an arbitrary state data collection. The resulting display should contain twenty hexadecimal words whose four most significant digits contain values somewhere between 0000 and 00FF. The rest of the digits should be all F's (see Figure 4-2). See Section 3 for additional state data collection examples.

* The NPC-800D emits a short beep upon power up or the pressing of the RESET key. This beep signifies that the NPC-800D has been reset.

```
MAIN          000  0040000FFFF
              001  0041B001FFFF
LOC:  000     002  0042A002FFFF
              003  0043C003FFFF
SIG: C1E7     004  0044200AFFFF
     19E7     005  0045A005FFFF
     D8D3     006  0046600AFFFF
              007  0047E007FFFF
              008  0048100BFFFF
              009  0049900BFFFF
              010  004A500AFFFF
              011  004BD00BFFFF
              012  004C300CFFFF
              013  004DB00DFFFF
              014  004E700EFFFF
              015  004FF00FFFFF
              016  0050081BFFFF
              017  0051881IFFFF
              018  0052481ZFFFF
              019  0053C813FFFF
              020  0054281AFFFF
              021  0055A815FFFF
              022  0056681GFFFF
              023  0057E817FFFF
```

Figure 4-2. Arbitrary State Data Collection For NPC-800D

4.2.3 Basic Timing Data Collection

1. To reinitialize NPC-800D, press RESET for approximately two seconds.

2. Insert a Model 81A Timing Probe into A (TIMING) input on left side of NPC-800D. Be sure plastic key on probe is facing up (you can leave state probe connected to analyzer).

3. Plug probe head into B side of Logic Analyzer's Test Card (there are no switch settings on this probe).

4. Turn power on. After CONFIGURATION LIST appears, move cursor down to 16-CHANNEL TIMING mode by pressing F4 key labeled SEL DOWN.

5. To take an arbitrary timing data collection, press F6, soft-key labeled COLLECT. This collection should contain sixteen high or low logic levels (see Figure 4-3). The 100 nanosecond sampling rate of the NPC-800D at power on is much faster than the clock rate of the CMOS test card. Therefore, few, if any, logic transitions will be captured (see Section 3 for additional timing collection examples).

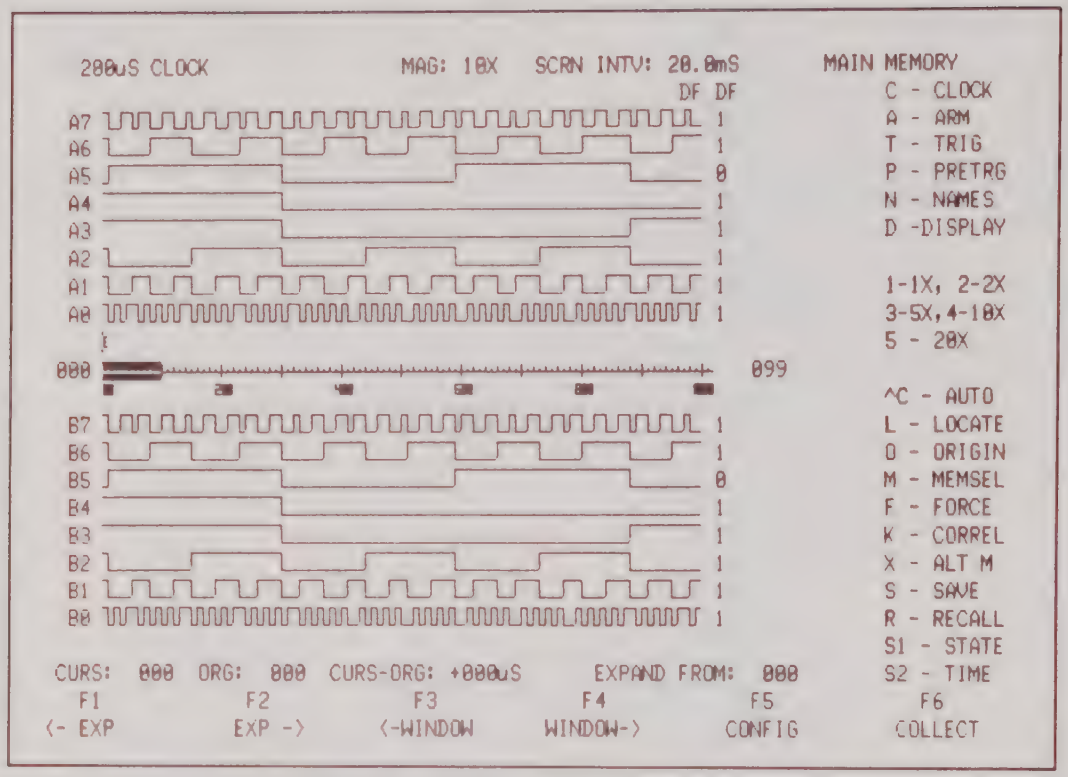

Figure 4-3. Arbitrary Timing Data Collection
(Your data are probably different)

4.2.4 Basic Waveform Collection (Option Must Be Installed)

1. Press F5, the soft-key labeled CONFIG. CONFIGURATION LIST should appear.

2. Using F4, the SEL DOWN key, step cursor down to Waveform mode.

3. Press COLLECT key. Since Model 90 (10X/1X) scope probe is not connected and there is no input signal, the waveform display contains only a baseline (see Figure 4-4) (If Waveform option is not installed, display will not contain baseline). See Section 3 for additional waveform collection examples.

4.2.5 Counter/Timer Collection

Repeat Steps 1 and 2 above except step to COUNTER/TIMER mode. Press F1 key. Since no input signal is present, readout inside display window should be all zeroes (if this option is not installed, display window is blank). See Section 3 for additional examples.

4.2.6 Signature Analyzer Collection

Repeat steps 1 and 2 above except step down to Signature Analyzer mode. Since no input or gating signals are present, no meaningful display is present (this test verifies presence of menu only). See Section 3 for additional examples.

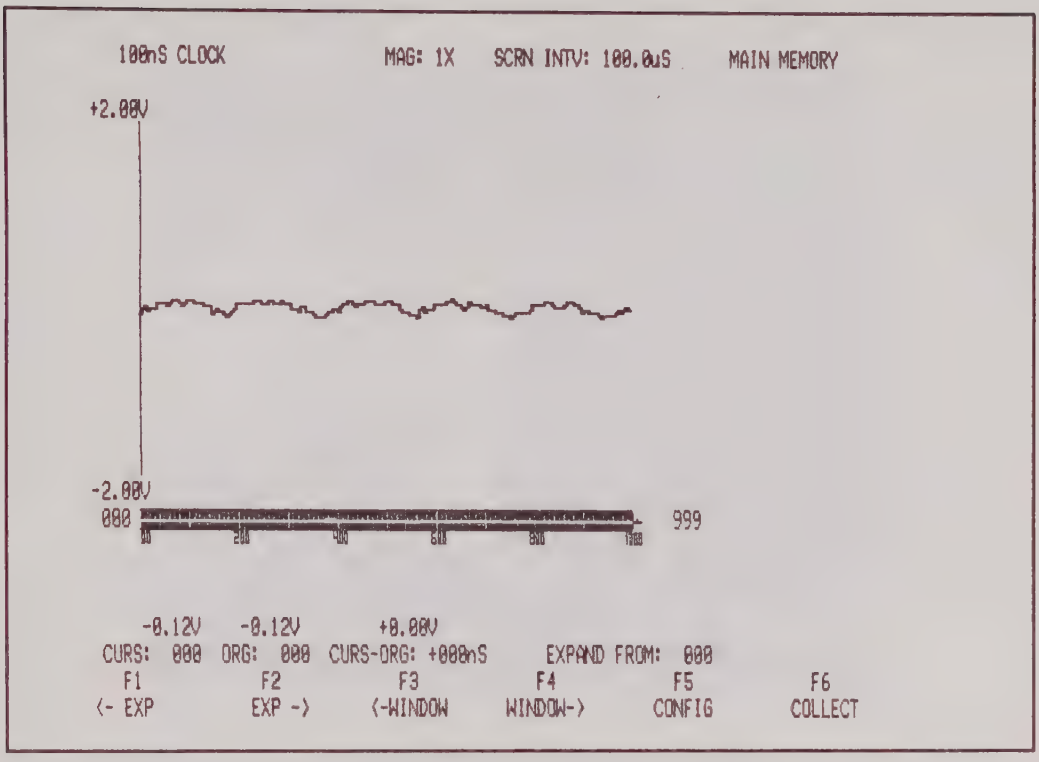

Figure 4-4. Waveform Display Without Input Signal

4.2.7 Disk Subsystem (NPC-800D)

When not in use, diskette should be kept inside its protective paper envelope. Recording medium on the diskette is protected within a sealed plastic jacket. DO NOT ATTEMPT TO REMOVE THE PLASTIC JACKET.

To insert diskette into disk drive, remove diskette from paper envelope. Notice the large, circular opening in the center of the diskette, the long oval READ/WRITE head opening, and a square WRITE PROTECT notch along one edge of diskette.

4.2.8 Diskette Insertion

To insert diskette, orient plastic jacket so that WRITE PROTECT notch is at the bottom and the label faces towards the CRT (see Figure 4-5).

Carefully slide diskette into vertical opening on drive until no additional movement in direction of insertion is possible. Now mount diskette to drive by rotating door handle 90 degrees to the right until handle latches, firmly clamping diskette onto drive motor spindle.

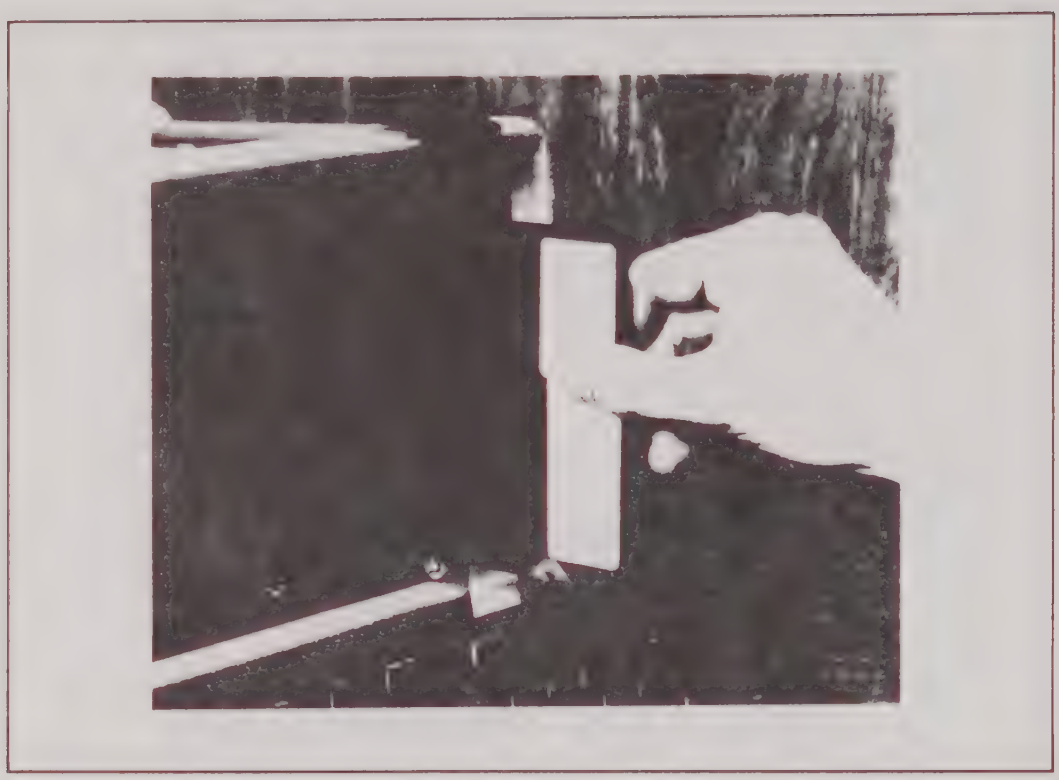

Figure 4-5. Loading Diskette

4.2.9 Diskette Removal

To remove diskette release latching mechanism. A partially ejected position is acceptable during power-up/down of the NPC-800D.

WARNING

To protect data on the diskette, it is good practice NEVER to interrupt power to the NPC-800D when a diskette is fully mounted on the drive.

4.2.10 Adjustments

The disk drive motor is part of a servo-controlled loop. It is independent of changes in line voltage and line frequency; therefore, no speed adjustment is necessary.

4.2.11 Operational Check of Disk Subsystem

1. If power was off, turn power on and insert a CP/M diskette as described above; otherwise, call CONFIGURATION LIST by pressing F5 key.

2. When CONFIGURATION LIST is displayed, press ESC (escape) key to exit analysis mode and enter CP/M mode (red LED on disk drive will illuminate).

3. Wait until a sign-on (header) and the CP/M prompt: A> appears. Next type DIR (directory) and press RETURN to see programs resident on disk (see Section 3 for additional CP/M information and examples).

4.3 SELF-TEST PROCEDURES

4.3.1 Introduction

Included on the disk that you receive with your NPC-800D (if you have a nonvolatile memory option) are three programs which perform a hardware and software self-test. Although these tests are not exhaustive, they do provide the user with a measure of confidence that the NPC-800D is operating properly. These tests are KYBDTEST.COM, which tests the keyboard: D800D.COM, which tests disk drives and diskette; and RAMTEST.COM, which tests the 48k of dynamic RAM. The PROCESSOR SELF-TEST (which tests processor's STACK, RAM, ROM, character generator, RS-232C interface IC, and 8155 timer IC) is in analyzer ROM and can be accessed whenever CONFIGURATION LIST is displayed.

With this extensive set of self-test programs, the user should be able to confirm whether the microcomputer portion of the NPC-800D is functioning properly. The analyzer portion can be further tested using Section 3 of this manual. Results of those examples are predictable so the user should have no trouble confirming whether the analyzer is functioning properly.

To perform the disk-resident self-test functions, turn power on, load diskette onto drive, press ESC to exit to CP/M, press CAPS LOCK to its down position, and type test file name that you want to execute.

4.3.2 Keyboard Test

To test the keyboard, type:

KYBDTEST (RETURN)

F1 F2 F3 F4 F5 F6 LABELS
ESC 1 2 3 4 5 6 7 8 9 0 - = ^ BS BK
TAB q w e r t y u i o p [ ] LF DEL
a s d f g h j k l ; ' { RETURN
S1
z x c v b n m , . /
S2
SPACE
UNLOCK CAPS LOCK KEY
PRESS EACH KEY ON KEYBOARD. ALL KEY LABELS SHOULD DISSAPPEAR

Figure 4-6. KYBDTEST

The program is loaded into RAM and begins executing. As shown in Figure 4-6, there should be a representation of the keyboard layout on the display. As you test each key, the associated key on the display disappears. Press each key in turn until all keys have been recognized and removed from the display. If you press a key which does not have a duplicate on the display, the program will allow you to stop the test or to continue (program does not know whether you pressed wrong key, or if keyboard is defective). As each key is pressed, the ASCII value (in HEX) of each key is displayed in upper left corner of CRT.

4.3.3 Disk Test

To perform disk test, type:

DSK5TEST (RETURN)

Figure 4-7. DSK5TEST

Answer each question asked by the program as shown in Figure 4-7. Unless you have more than one disk drive installed, your answer to the SELECT DRIVE statement will always be A. The number of retries to select (attempts to retest a specific block of the diskette upon encountering a failure) is determined by you. Normally, that number should be 0. The drive reads each track in sequence. However, if you answer "Y" to FULL TRACK SEEK, the drive steps back to track zero after reading each track and then proceeds to next track in the sequence. When test is complete, you have the option to repeat the test once, continuously, or not at all.

4.3.4 RAM Test

To perform a test of the dynamic RAM (not high speed analyzer RAM), type:

RAMTEST (RETURN)

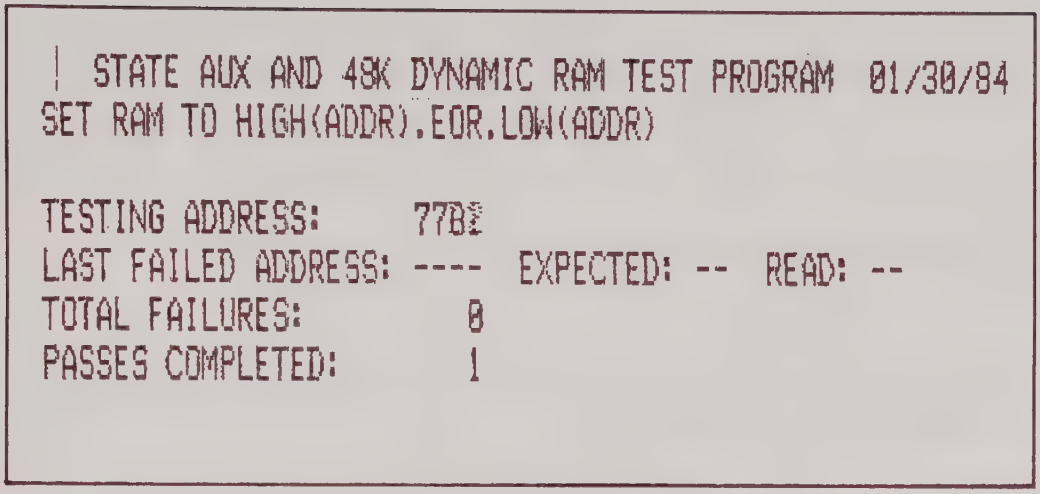
STATE AUX AND 48K DYNAMIC RAM TEST PROGRAM 01/30/84
SET RAM TO HIGH(ADDR).EOR.LOW(ADDR)
TESTING ADDRESS: 77B
LAST FAILED ADDRESS: ---- EXPECTED: -- READ: --
TOTAL FAILURES: 0
PASSES COMPLETED: 1

Figure 4-8. RAMTEST

The program performs a fast READ and WRITE, then begins a "walking ones and zeroes" test. This portion of the test is quite long, so you might not want to monitor this test, merely check the results (see Figure 4-8).

4.3.5 Processor Self-Test

To call CONFIGURATION LIST, press RESET. Press BREAK key to execute PROCESSOR SELF-TEST as shown in Figure 4-9.

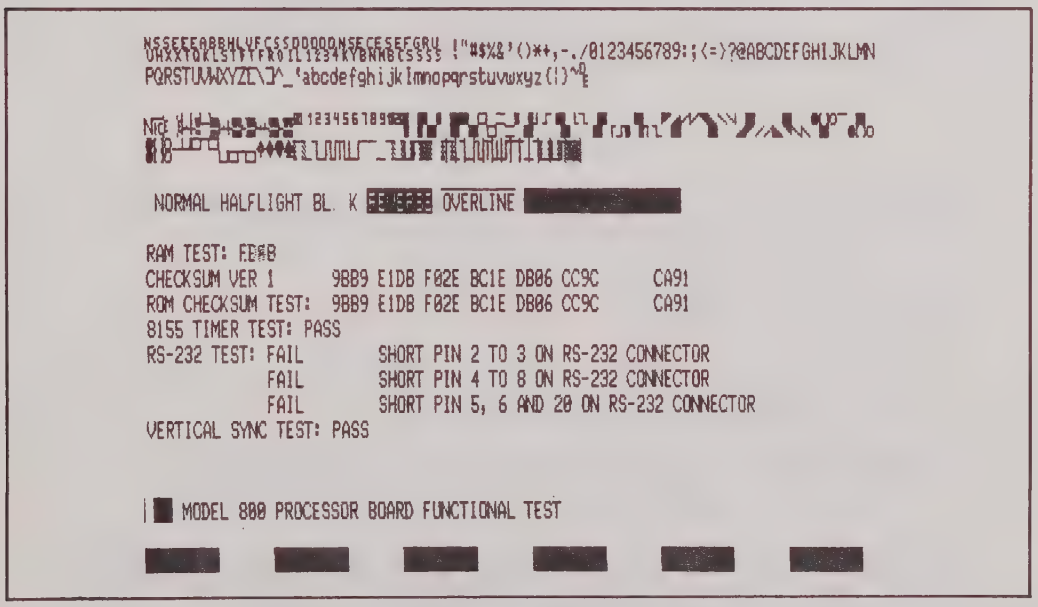
NORMAL HALFLIGHT BL. K OVERLINE
RAM TEST: FE%B
CHECKSUM VER 1 9BB9 E1DB F02E BC1E DB06 CC9C CA91
ROM CHECKSUM TEST: 9BB9 E1DB F02E BC1E DB06 CC9C CA91
8155 TIMER TEST: PASS
RS-232 TEST: FAIL SHORT PIN 2 TO 3 ON RS-232 CONNECTOR
FAIL SHORT PIN 4 TO 8 ON RS-232 CONNECTOR
FAIL SHORT PIN 5, 6 AND 20 ON RS-232 CONNECTOR
VERTICAL SYNC TEST: PASS
MODEL 800 PROCESSOR BOARD FUNCTIONAL TEST

Figure 4-9. Processor Self-Test

The program first prints both character sets located on top of display. It then prints each of the "attributes" used in the display: NORMAL video, HALFLIGHT video, BLINKING messages, full intensity REVERSE video, OVERLINE, and HALFLIGHT REVERSE video.

Next it performs a test of the stack RAM and checksum of each ROM. The first row of checksums is the reference data stored in ROM. The second row is the result of the current checksum calculation. Finally, the 8155 timer IC and the RS-232C* interface IC are tested. This test is repeated continuously, so press RESET to exit from this program.

* For RS-232C test to pass, you must connect the TRANSMIT pin (3) to the RECEIVE pin (2).

4.4 RETURNED MATERIAL AUTHORIZATION

4.4.1 Return of Equipment

If your unit must be sent back to the factory or an authorized service center for any reason, contact Nicolet Paratronics or your local sales office for instructions and a RETURN AUTHORIZATION NUMBER.

NOTE

EQUIPMENT RETURNED TO THE FACTORY OR SERVICE CENTER WITHOUT PRIOR AUTHORIZATION WILL ONLY DELAY THE REPAIR PROCESS. BY FIRST CONTACTING NICOLET PARATRONICS, WE MIGHT BE ABLE TO SOLVE YOUR PROBLEM AND SAVE YOU A LOT OF TROUBLE.

4.4.2 Suggestions Concerning Return of Equipment

If you have authorization to return equipment, use original shipping container and packing material, if possible. Also, it is always a good idea to insure any equipment shipped.

If subassembly, board, PROM, diskette, or other component responsible for the problem can be identified (with or without the help of our application engineers), it is often more convenient, and certainly less costly, to return just the faulty item rather than entire instrument.

IMPORTANT NOTE

U.S. CUSTOMERS SHOULD CONTACT OUR CUSTOMER SERVICE DEPARTMENT FOR ASSISTANCE AT THESE PHONE NUMBERS

- ☐ *(800) NICOLET (Toll-Free outside California)*
  (415) 490-8300 (California)
- ☐ *OUR CUSTOMER SERVICE ENGINEERS CAN ANSWER QUESTIONS AND AUTHORIZE RETURN OF EQUIPMENT.*
- ☐ *INTERNATIONAL CUSTOMERS SHOULD DEAL DIRECTLY WITH THEIR LOCAL NICOLET PARATRONICS' SALES AND SERVICE CENTER.*

No matter the procedure, please send a description of the problem along with the faulty item. If you return the entire instrument, INCLUDE ALL PROBES AND ACCESSORIES. Refer to Section 2 for more information.

Section 5
Option Installation

5.1 INTRODUCTION

To enhance the capabilities of your NPC-800D, you have several options from which to choose. Some of those options may be installed in the field, and some require that the instrument be returned to the factory or to an authorized service facility for installation.

The table below summarizes which options are internal to the logic analyzer, which are external, and whether they can be installed by the user. Those that permit field installation are easy to install and can be installed using ordinary hand tools.

Option Description	Internal/ External	Field/ Factory
Nonvolatile Memory	Internal	Factory
Waveform Recorder	Internal	Field
Counter-Timer	Internal	Field
Second Disk Drive	Internal	Field
Performance Analysis	Internal	Field
Printer Software	Internal	Field
Computer/Controller	Internal	Field
Printer	External	Field
Dedicated Probes	External *	Field
In-Circuit Emulators	External	Field
Upgrade of Basic Analyzer	Internal	Factory

* Each dedicated probe consists of a special microprocessor hardware interface and software or firmware to display collected information in an easy-to-read format. For those NPC-800Ds with the Nonvolatile Memory option, that software resides on a diskette and requires no internal installation. However, for those NPC-800Ds that do not have the Nonvolatile Memory option, that software resides on an EPROM, and requires that you install that EPROM on one of the circuit boards inside the NPC-800D.

Section 6
Glossary

Acquisition The process by which input logic signals are compared at a discrete instant to a threshold level and recorded.

Active Clock Edge The clock transition on which all receivers (listeners) interpret the data on the bus. A logic analyzer must monitor the system using this same active edge as its clock.

Address Bus That bus in the system used to address or define the memory or device location enabled.

Aliasing The misleading display of a sampled analog waveform when the sample rate is less than twice the input frequency.

Arm An input or condition that must occur prior to the analyzer trigger conditions being recognized. See Trigger Enable.

ASCII American Standard Code for Information Interchange; a standard alphanumeric code defining a character set.

Assemble To combine routines to form a program; to translate a source program into a machine language, usually producing one machine language instruction for each source language instruction.

Assembly Language A language of mnemonics (resembling English more closely than 1's and 0's) that defines the machine instruction to be executed.

Asynchronous Clocking Data is clocked into the logic analyzer at a rate unrelated to the system under test. See Timing Analyzer, Synchronous Data.

Asynchronous Data Data that is not referenced to time. The completion of one operation signals the next operation.

Asynchronous Triggering Triggering of timing analyzer by signals independent of the analyzer clock.

Automatic Test A capability of some analyzers that allows the storage of a partial or complete test procedure, plus the expected results, in an auxiliary memory. Tests are then executed with minimal user intervention.

Auxiliary Memory Space in memory in addition to the active recording memory. It may include RAM and PROM and is used in comparing data, halting on difference, automatic testing and other functions.

Baud Rate The number of symbols per second that are transmitted (a symbol normally consists of one bit.)

Block Transfer The movement of a group of fields from one group of addresses to another group of addresses.

Bootstrap The instructions at the beginning of a program together with a few instructions entered from the control console used to load a program into RAM; a minimal-size loader program.

Branch See Transfer Command.

Breakpoint A point in a program in which a process(or) may be made to stop automatically for a check on the progress of the data handling. See Emulator.

Bus System A network of paths or set of lines that facilitate data flow in a digital system. The common buses are the address, data, and control buses.

Call To place the necessary initial values of variables in the required addresses and then to transfer control to a subroutine. See Transfer Command.

Clock The pulses that control the timing of operations in a digital system; some systems having more than one clock. Both the system and any monitoring instrument must interpret the data on an active clock edge when all data are valid.

Clock Delay The number of occurrences of a clock before an event.

Clock Qualifier Additional logic analyzer inputs that may or may not be displayed that define conditions as to when data may be sampled or displayed. A sample is taken only on an active clock edge provided the clock qualifier conditions are satisfied. See Active Clock Edge, Sampling.

Clock Slope The transition or active edge at which the analyzer samples data. See Edge Sensitive.

Combinational Trigger The pattern of 0's, 1's, and "don't cares" set on all channels that, when matched by the sampled data, causes a trace to commence.

Comparator A circuit that compares two or more signals and supplies an indication of their agreement or disagreement to initiate some other action.

Compare Data Any form of display in which a captured data record is manipulated with the data set in an auxiliary memory in such a way as to make differences conspicuous. Two examples: the "exclusive-OR" display and rapid alternation of the display between recording and auxiliary memories.

Compiler A routine by which a computer can translate a source program into an object program by assembling and copying from other programs stored in a library of routines.

Composite Video An analog signal containing not only display information but also horizontal and vertical synchronizing pulses, all of standard polarity and size.

Concatenate To connect or link elements in a series or chain to form a whole.

Conditional Transfer An instruction that causes the processor either to continue with the next instruction in the original sequence or to change control to some other designated instruction, depending upon the result of some logic operation. See Transfer Command.

Contents The word or field stored at a given address or in a given register.

Control Character A character embedded in operand data that specifies an operation to be done, such as skip to a new page while printing output data.

Correlation A comparison function; a figure of merit, indicating the number of similarities relative to the number of differences between two elements.

CR Carriage Return; a control character used to end an input from a keyboard; refers to the mechanical carriage on a printer returning to begin another line, requiring a finite amount of time.

Cross Compiler A special utility program allowing compiling of code for a processor which differs from the host.

Cross-Domain Linkage Linkage between the state, timing, and analog domains. See State Analyzer, Timing Analyzer.

CT/SA Counter-timer/signature analyzer. See Time Measurements.

Data Compression Any display technique intended to reduce the time or effort required to examine an entire data record. The simplest form converts binary words into hexadecimal words. One of the more effective techniques is signature analysis. See Signature Analysis.

Data Domain A domain concerned with the total amount of data that must be collected at every event/time in order to characterize synchronous system behavior. A logic analyzer is a data domain monitoring instrument.

Data Qualified Clocking Specifying a data pattern that is logically ANDed with the clock, to exclude "non-qualified" clock occurrences.

Data Rate The clock rate for synchronous systems; it must not exceed the specified maximum clock rate of the analyzer.

Debugger A program used to facilitate testing of a microprocessor system.

Decision In computer operations, the processes of detecting the existence of specified patterns of relationships in the data being handled, and of taking alternative courses of action based upon the differences detected. See Transfer Command.

Dedicated Probe (Personality Probe) A probe used to examine a particular microprocessor chip used by clipping over the processor and passively monitoring its state transaction.

Delay User set for an N-count of selected events. Delay is used to offset in time the position of the final data record with respect to the triggering event. See Clock Delay, Trigger Delay.

Demultiplexing (Demux) The sorting of multiple signals which time-share a signal path into dedicated lines (channels).

Density Referring to a memory diskette, how closely information is packed on a track.

Diagnostic Routine A routine designed to locate either a malfunction in a computer system or a mistake in coding.

Disassembly The reverse of assembly; to convert machine language code into user recognizable mnemonics, usually done with the help of a dedicated personality probe. See Assembly Language, Dedicated Probe.

Diskette A flexible mylar oxide-coated storage device, commonly known as a floppy.

Display Polarity If a logic one at the probe input is displayed as a logic zero on the CRT, the display polarity is said to be inverted (−). If a 1 at the probe inputs is displayed as such, the polarity is normal (+).

DMA Direct Memory Access is the transfer of I/O information to memory by bypassing the processor.

Don't Care A channel that may be in either state "0" or state "1," symbolized "X," thereby not restricting data qualification if used in a qualifier word.

Don't Care Triggering A triggering condition where all of the trigger bits are don't care. The first data that comes along will be traced.

Edge Sensitive Response of a system to rising (positive) or falling (negative) or trailing transitions as opposed to levels of the clock. See Active Clock Edge.

Edit To arrange, rearrange, or arbitrarily alter information, especially in format.

Emulator Hardware containing a microprocessor that replaces the target system's microprocessor and permits execution and interaction with the user's program.

External Trigger An active signal or an external logic analyzer input that will start (trigger) the analyzer. See Trigger.

Field (in a menu) One or more adjoining characters treated as a group.

File A set of records on a common subject and usually organized or ordered on the basis of some combination of items of data uniformly found in all the records of the file, such as a date.

Filter A circuit that ensures trigger conditions (i.e., Boolean combinations) are satisfied for a minimum time before actually triggering the analyzer.

Flow Chart (diagram) An analysis technique providing a graphic presentation of a procedure. In programming, a chart setting forth the particular sequences of operations to be done in a computer to handle a particular application.

Format An arrangement of information on a form, document, or in storage. Configuration of a logic analyzer, e.g., arbitrary labels given to input channels, clock and logic polarities, and display presentation.

Glitch Memory An auxiliary memory that stores the presence of any glitches between sample periods.

Glitch Triggering Triggering on a glitch on any specified channel. Usually combined with other logic level requirements on all lines.

Halt on Difference The trigger caused by any detected difference, when incoming data is continually compared to the contents of an auxiliary memory. See Hold ≠.

Hold ≠ A trigger mode that causes a logic state analyzer to continually collect data until a difference is detected between main and auxiliary reference memories. The last collection is held for display with differences intensified.

Hold-Time The time following the active clock edge where the analyzer may sample data. Since many systems do not hold the data past the active clock edge, a logic analyzer should have a zero hold time ideally.

Housekeeping Computer operations which do not directly contribute to useful data handling—extracting of fields, verifying the identification of the input, etc.; in general, the setup (including initialization) and cleanup operations in a program.

In Circuit Emulation See Emulator.

Independent CLK/TRIG Qualification The concept of forced acceptance of an otherwise not qualified trigger word; occurring before or after (i.e., displaced from) the clock qualification. See Clock Qualifier, Trigger Qualifier.

Initialization When first powered up, a processor will have a random program counter value so that setting variables and control indicators in a program to their starting values is necessary.

Instruction A word or field that directs the automatic computer to take a certain action. The instruction usually consists of a command together with one or more operand addresses, which, taken together, cause the computer to act upon the indicated operands.

Intelligent Controller Referring to GPIB instruments it is the director of any transactions on the bus equipped with a microprocessor.

Interpretive Routine An executive routine which, during the course of data-handling operations, translates a stored macrocoded program into a machine code and at once performs the indicated operations by means of subroutines.

Interrupt An external control system used to suspend normal operations and possibly cause new sequences of instructions to be followed.

Inverse Video A black on white display used to highlight trigger words; or in serial displays, the data received. In formatting an analyzer, it is used to indicate user-definable parameters.

Iterative Loop A repeated group of instructions in a routine.

Jump See Transfer Command.

Label An identifier, in either human or machine language, e.g., a magnetic tape label identifying the tape or an address identifying a storage location, or an alphanumeric character representing an input channel.

Latch A glitch latch detects narrow pulses and stretches them such that they are traced by the clock.

LF Line Feed. See Carriage Return.

Library Routines A collection of standard and fully debugged programs, routines, and subroutines by means of which many types of problems and parts of problems can be processed or handled.

List A string with pointers (called links) added to each data element to enable their logical sequence to be different from their physical sequence.

Listener A device in a digital system that is reading data from the bus.

Load Routine A routine which causes a computer to transfer object code into RAM storage. See Bootstrap.

Lockout The recognition by the processor of an illegal or impossible triggering requirement. Simplification of the restraining conditions is recommended.

Lookup Table A memory structure, typically a ROM, where a specific address yields specific yet repetitive data. The process of finding a function in a table when provided with a key and arguments.

Loop An iterative routine, usually subject to instruction modification in a progressive manner until an exit condition is reached.

Machine Language Information represented in a form which an automatic computer can handle directly. For example, the result of assembling a symbolic source program is the machine language object code.

Macro, Macrocommand, Macroinstruction A symbolic command or instruction that is translated into two or more machine language instructions (often an entire subroutine) by the translator program.

MDS Microprocessor Development System; a system of hardware and software used to develop and help debug microprocessor-based products. See Emulator, State Analyzer, Timing Analyzer.

Microprocessor Analyzer A special logic state analyzer that monitors microprocessor bus systems and displays the results in microprocessor mnemonics. See Dedicated Probe.

Microprogram A basic command repertoire for an automatic computer that consists only of basic elemental operations which the programmer can combine into commands to suit his/her own convenience and in terms of which he/she would then program.

Mnemonic A set of symbols that combine a series of 0 s and 1 s, as used by a machine, into symbols that suggest the instruction to a human (for example, LDA is Load Accumulator).

Monitor To execute a program under the control of an executive routine; an executive routine capable of controlling the execution of a number of different programs one immediately after the other, including the clean up and restart between each program, thus relieving the operating personnel of some control functions and reducing computer idle time. See Operating System.

Multiphase Clocking Input data is organized as multiple words in width, each word with its own clock input. User may select positive or negative-going edges for each clock — a necessary capability when the analyzer is used with a microprocessor that multiplexes data and address information on the same bus (for example, the Intel 8085).

Multiple Occurrences Part of the trigger conditions that require the analyzer to find the trigger state a specified number of times in order to completely satisfy the trigger conditions. See Clock Delay, Trigger Delay.

Multiplexed The process of transmitting more than one set of signals over one bus; e.g., address and data information could occur at different times on the one bus. Information on the bus is defined by the control signals.

Negative Logic Refers to a logic "0" being true; a common misconception is that it refers to negative voltage levels.

Negative Time Events that occur before the defined trigger conditions are satisfied are said to occur in negative time. See Pretrigger.

Nested Loop A subroutine enclosed within a larger subroutine.

Nibble Half of a byte.

Non-occurrence Trigger In the sequential triggering mode, means trigger, if any word other than B occurs N events after A. It can have meaning for parallel triggering, if the inputs are organized as two words. Then the term means trigger if one word and anything but the other word occur simultaneously. See NOT Trigger.

NOP An instruction causing no change in the processor except a normal increment of the program counter, in other words, to go to the next instruction.

NOT Trigger A trigger condition that initiates data acquisition any time a state other than the state specified occurs. Also known as non-occurrence triggering.

Object Program A program produced by some translation process, as by the use of a compiler routine, from a source program. An object program need not be in a machine language, but often is.

Op Code The portion of a software instruction set that defines the next operation to be performed. Often extra information (the operand) will be required to define the data or location on which the op code will operate. See Dedicated Probe, Mnemonic.

Operand The part of an instruction to a processor that defines the data or the location to which the op code refers; something acted upon.

Operating System An executive routine and other supporting programs used to assist and control, in part, the operation of a computer. See Monitor.

Parallel Trigger The event caused by the occurrence of a selected word (or simultaneous occurrence of two words, like address and data) at the inputs. One of the obvious advantages of logic analyzers over conventional analog oscilloscopes.

Parity Check A type of redundant check in which the evenness or oddness of the number of 1 bits is verified.

Pass Count See Clock Delay, Trigger Delay.

Patch A correction made to a program and usually inserted into the control sequence by unconditional transfers of control.

Pointer A means of designating the address or name of something. See Label.

Positive True Logic Refers to a logic "1" being true.

Polling A technique in which multiple I/O devices time-share an I/O channel without contention.

Post Processing Processing of data after the collection is complete. For example, determining the number of occurrences of a specific data pattern.

Post-trigger Positive Triggering. Post-trigger means the captured record consists of data, all or most of which occurred after the trigger.

Pretrigger Negative Triggering. Pretrigger means that the captured record consists of data, all or part of which occurred before the trigger. It can never be greater than the memory capacity.

Probe The pod on the logic analyzer that actually connects to the circuit under test. Important criteria are probe loading and speed capability. The mechanical interface to the system under test. A basic probe consists of a ribbon cable terminating in a pod with flying leads. The pod contains input buffers and sometimes other circuitry, which can, for example, set the logic threshold.

Program A set of in-sequence, coded instructions for a digital computer, sometimes known as a routine or a subroutine.

Program Counter An essential register in a CPU keeping track of where a program is.

Protocol The sequence of events or the format of signals or lines that must occur for the correct operation of a system.

Qualifier An additional input, not necessarily recorded as data, but used to enable the trigger or the analyzer's clock input.

Radix (base) The fundamental number of a number system, e.g., 10 in the decimal system.

Restart Used with sequential trigger to restart the trigger sequence should a given state occur; useful when a critical branch is encountered in program flow.

Resolution The time interval over which a transition displayed by a timing analyzer may have occurred. For a single channel this will be 1 clock period. Between channels, the resolution should be ± 1 clock period.

Routine A program, or a part of a program.

Sample Window The sample window consists of set-up and hold times and is the time about the sample instant when the analyzer registers data.

Sampling Examining a voltage at discrete instances in time with the implied assumption that the waveform is constant until the next sample strobing.

Scroll The rolling or shifting of the logic analyzer display window through the analyzer memory.

Sector The subdivision of a track on a memory disk. On floppy diskettes two versions are available: hard and soft sectored.

Sector Access Hole A small hole on the floppy diskette jacket through which the index hole can be sensed by the disc drive timing sensor.

Selective Trace A data collection where the data sampled is selectively edited before being stored in memory; performed to conserve memory space.

Sequential Trigger A trigger condition that must be satisfied by a series of states in the specified sequence. The event caused when and only when data word B follows data word A by N selected events. N is usually set by the delay function.

Serial Data Bus A bus on which the data is all transferred bit- by-bit in a serial manner.

Set-Up Time The time prior to the active clock edge during which data may be sampled by the analyzer. Therefore, the data must be valid for at least this interval.

Signature Analysis A technique for data compression, in which the entire data record is compacted into one or more 4-character words through an algorithm that weights each bit equally. For all practical purposes, this signature is unique to the data and may be compared to a known, good signature.

Simulator A program used in a host computer to test the correctness of machine code. See Emulator.

Single Step To execute a program on a step-by-step basis.

Skew The difference in the delays across channels as measured between the probe tip and the point when the data is interpreted by the analyzer.

Soft-Key A key that serves different purposes at different times, as defined by software, and is labeled accordingly.

Source Program A program that is to be translated to an object program; for example, a program written in a symbolic language.

Stack A group of storage locations used to temporarily store data, in a modified sequence, according to the last location, unlike a program counter.

State Analyzer State-sequences of a digital system are recorded for analysis with a logic state analyzer.

Storage Dump A read-out or printout of the contents of a storage device. Usually only the contents of internal storage are dumped, and usually the read-out is onto magnetic tape or disks, and the printout onto paper via a line printer or typewriter.

Synchronous Analyzer Traces data which are synchronized with the clock of the system under observation. See State Analyzer.

Synchronous Data Data that coincides or is valid with a defined clock or control signal.

System Clock Clock signal provided by the system under test.

Table A listing. See State Analyzer.

Talker A device in the system that is putting data onto the IEEE-488 bus.

Text Editor A program used to develop and modify source programs, used before translation to an object program.

Threshold A signal amplitude level that divides one state from a second. A facility that allows the threshold on a logic analyzer to be varied either for different logic families or to check marginal data transitions.

Threshold Adjust An adjustment control on a logic analyzer used to vary the voltage level that defines what a logic analyzer will interpret as a logic "0" or logic "1." This can be software programable or a hardware adjustment point. See Variable Threshold.

Threshold Range Spread of threshold voltage to accommodate different logic families.

Time Out If a trigger event does not occur within a preset time, a trigger event will be forced.

Time Measurements Time measurements with logic analyzers that may be relative (between samples), absolute (from trigger word), or between states and trigger stack levels, or between edges of specific traces.

Timing Analyzer A timing analyzer monitors the activity of a digital system and presents its observations as a state-time display or a pseudo-waveform of logic levels and transitions.

Trace Programming To follow the control sequence instruction-by- instruction, usually producing a printout reporting the consequences of each instruction; a routine for doing tracing. A hardware trace is the video display of a logic waveform.

Track The path on which data is recorded on a floppy diskette, lying directly beneath the read/write head.

Transfer Command A signal that conditionally or unconditionally specifies the location of the next instruction and directs the CPU to that instruction. See Conditional Transfer.

Transfer Rate The speed of data transmission, usually quoted in characters (baud) or bits per second.

Transient Triggering Triggering of a timing analyzer on a state that only occurs as a transient. See Hold ≠.

Trigger A word, or sequence of words or events, that defines the point where a logic analyzer references its trace to the system activity, the start of a data collection process. To initiate the capture of a data record. Loosely, it may refer to the triggering event. See Parallel, Sequential, Non-occurrence, Pre and Post-trigger.

Trigger Delay Delay added so that the Nth word past the trigger is recorded by the logic analyzer.

Trigger Disable A condition or state that cancels the trigger enable. See Restart.

Trigger Enable A state that must occur before the trigger word will be recognized. See Arm.

Trigger Output A synchronizing signal out of a logic analyzer that signifies that trigger conditions are met. It may be used to synchronize external instruments such as oscilloscopes or to arm a second analyzer. See Comparator.

Trigger Qualifier A combinatorial signal (word) that places constraints on satisfying trigger conditions; i.e., the analyzer is triggered only when the specified trigger state and the trigger qualifier conditions occur. See Data Qualified Clocking.

Utility Routine A routine to perform functions auxiliary to the running of other programs. Examples are storage dump routines, bootstrap routines, tape label routines.

Variable Threshold A type of probe that allows user-adjustment of the logic threshold voltage reference. User can adapt the analyzer to different logic families or to test noise immunity. See Threshold.

Waveform A modified timing mode, with an A/D converter as the front-end of the analyzer which performs like a digitizing oscilloscope.

Appendix A
Conversion Tables

A.1 ASCII & GPIB Code Chart

B7 B6 B5 / BITS / B4 B3 B2 B1	0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 1
	CONTROL		NUMBERS SYMBOLS		UPPER CASE		LOWER CASE	
0 0 0 0	0 BREAK NUL 0 0	20 DLE 10 16	40 0 SP 20 32	60 16 0 30 48	100 0 @ 40 64	120 16 P 50 80	140 0 ` 60 96	160 16 p 70 112
0 0 0 1	1 GTL SOH 1 1	21 S1 LLO DC1 11 17	41 1 ! 21 33	61 17 1 31 49	101 1 A 41 65	121 17 Q 51 81	141 1 a 61 97	161 17 q 71 113
0 0 1 0	2 STX 2 2	22 S2 DC2 12 18	42 2 " 22 34	62 18 2 32 50	102 2 B 42 66	122 18 R 52 82	142 2 b 62 98	162 18 r 72 114
0 0 1 1	3 ETX 3 3	23 F1 DC3 13 19	43 3 # 23 35	63 19 3 33 51	103 3 C 43 67	123 19 S 53 83	143 3 c 63 99	163 19 s 73 115
0 1 0 0	4 SDC EOT 4 4	24 F2 DCL DC4 14 20	44 4 $ 24 36	64 20 4 34 52	104 4 D 44 68	124 20 T 54 84	144 4 d 64 100	164 20 t 74 116
0 1 0 1	5 PPC ENQ 5 5	25 F3 PPU NAK 15 21	45 5 % 25 37	65 21 5 35 53	105 5 E 45 69	125 21 U 55 85	145 5 e 65 101	165 21 u 75 117
0 1 1 0	6 ACK 6 6	26 F4 SYN 16 22	46 6 & 26 38	66 22 6 36 54	106 6 F 46 70	126 22 V 56 86	146 6 f 66 102	166 22 v 76 118
0 1 1 1	7 TAB BEL 7 7	27 F5 ETB 17 23	47 7 ' 27 39	67 23 7 37 55	107 7 G 47 71	127 23 W 57 87	147 7 g 67 103	167 23 w 77 119
1 0 0 0	10 GET BS 8 8	30 F6 SPE CAN 18 24	50 8 (28 40	70 24 8 38 56	110 8 H 48 72	130 24 X 58 88	150 8 h 68 104	170 24 x 78 120
1 0 0 1	11 TCT HT 9 9	LABELS EM 19 25	51 9) 29 41	71 25 9 39 57	111 9 I 49 73	131 25 Y 59 89	151 9 i 69 105	171 25 y 79 121
1 0 1 0	12 LF A 10	32 SUB 1A 26	52 10 * 2A 42	72 26 : 3A 58	112 10 J 4A 74	132 26 Z 5A 90	152 10 j 6A 106	172 26 z 7A 122
1 0 1 1	13 VT B 11	33 ESC 1B 27	53 11 + 2B 43	73 27 ; 3B 59	113 11 K 4B 75	133 27 [5B 91	153 11 k 6B 107	173 27 { 7B 123
1 1 0 0	14 FF C 12	34 FS 1C 28	54 12 , 2C 44	74 28 < 3C 60	114 12 L 4C 76	134 28 \ 5C 92	154 12 l 6C 108	174 28 | 7C 124
1 1 0 1	15 CR D 13	35 GS 1D 29	55 13 - 2D 45	75 29 = 3D 61	115 13 M 4D 77	135 29] 5D 93	155 13 m 6D 109	175 29 } 7D 125
1 1 1 0	16 SO E 14	36 RS 1E 30	56 14 . 2E 46	76 30 > 3E 62	116 14 N 4E 78	136 30 ^ 5E 94	156 14 n 6E 110	176 30 ~ 7E 126
1 1 1 1	17 SI F 15	37 US 1F 31	57 15 / 2F 47	77 UNL ? 3F 63	117 15 O 4F 79	137 UNT _ 5F 95	157 15 o 6F 111	177 DEL (RUBOUT) 7F 127
	ADDRESSED COMMANDS	UNIVERSAL COMMANDS	LISTEN ADDRESSES		TALK ADDRESSES		SECONDARY ADDRESSES OR COMMANDS	

KEY

octal / hex — 25 PPU / NAK / 15 21 — GPIB code / ASCII character / decimal

REF: ANSI STD X3.4-1977
IEEE STD 488-1978

A.2 Hex-Decimal

F E D C		B A 9 8		7 6 5 4		3 2 1 0	
Hex	Decimal	Hex	Decimal	Hex	Decimal	Hex	Decimal
0	0	0	0	0	0	0	0
1	4,096	1	256	1	16	1	1
2	8,192	2	512	2	32	2	2
3	12,288	3	768	3	48	3	3
4	16,384	4	1,024	4	64	4	4
5	20,480	5	1,280	5	80	5	5
6	24,576	6	1,536	6	96	6	6
7	28,672	7	1,792	7	112	7	7
8	32,768	8	2,048	8	128	8	8
9	36,864	9	2,304	9	144	9	9
A	40,960	A	2,560	A	160	A	10
B	45,056	B	2,816	B	176	B	11
C	49,152	C	3,072	C	192	C	12
D	53,248	D	3,328	D	208	D	13
E	57,344	E	3,584	E	224	E	14
F	61,440	F	3,840	F	240	F	15

A.3 Hex-Decimal-ASCII Equivalent For Soft-Keys

KEY	HEX	ASCII	DECIMAL
S1	11	CONTROL-Q	17
S2	12	CONTROL-R	18
F1	13	CONTROL-S	19
F2	14	CONTROL-T	20
F3	15	CONTROL-U	21
F4	16	CONTROL-V	22
F5	17	CONTROL-W	23
F6	18	CONTROL-X	24
LABELS	19	CONTROL-Y	25

OCTAL	BINARY
0	000
1	001
2	010
3	011
4	100
5	101
6	110
7	111

HEX	BINARY
0	0000
1	0001
2	0010
3	0011
4	0100
5	0101
6	0110
7	0111
8	1000
9	1001
A	1010
B	1011
C	1100
D	1101
E	1110
F	1111

Example: Convert (7412) OCT to HEX equivalent

Procedure:	7	4	1	2	OCTAL WORD
	111	100	001	010	OCTAL BINARY GROUPING
(Extra Zeroes	0000)	1111	0000	1010	HEX BINARY GROUPING
	0	F	0	A	HEX WORD

Thus: (7412) OCT = (0F0A) HEX

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